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Kentucky Geological Survey

CHARLES J. NORWOOD, Director.

COUNTY REPORT No. 4

SERIAL No. 20

REPORT ON

The Geology and Economic Resources

OF

ROCKCASTLE COUNTY.

By F. JULIUS FOHS.

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GEOLOGY AND ECONOMIC RESOURCES OF ROCKCASTLE COUNTY.

By F. Julius Fohs.

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LETTER OF TRANSMITTAL.

His Excellency, AUGUST E. WILLSON,

Governor of Kentucky.

Sir:

I have the honor to transmit herewith for publication a report on the geology and economic resources of Rockcastle county, by F. Julius Fohs. The field work for the report was carried on during the past summer.

Very respectfully,

CHARLES J. NORWOOD,

Director, State Geological Survey.

September 1, 1910.

CHAPTER I.

INTRODUCTORY.

History and Geography.—Rockcastle, the 52d county of Kentucky was formed from parts of Lincoln, Madison, Pulaski, and Knox counties in 1810; it derived its name from the Rockcastle river which forms its southeast boundary. Daniel Boone's trace and Skagg's trace, the former leading to Boonesborough, (Kentucky's earliest settlement) on the north border of Madison county, and Skagg's trace leading to Crab Orchard are said to be still visible at some points in the county. Early immigrants were defeated in two encounters with the Indians; one of these battles was between them and the McClure family and company, which took place near the head of the East fork of Skaggs creek, and the other was that of Capt. Baughman and company on Negro creek.

During the war of 1812, Big or Great Saltpeter cave gave employment to between 60 and 70 laborers in the manufacture of saltpeter. During the Civil war, the battle of Camp Wild Cat or Rockcastle Hills was fought October 21, 1861, near Livingston at the junction of the three roads leading respectively to Mt. Vernon, Richmond, and London; this resulted in a Federal victory. Otherwise the county has had a rather uneventful history.

The county is situated between longitude 84° 8′ and 84° 30′, and latitude 37° 9′ and 37° 32′. It is bounded on the north by Garrard and Madison, on the west by Lincoln, on the southwest by Pulaski, on the southeast by Laurel, and on the east by Jackson county. Rockcastle county has an area of 308 square miles (197,120) acres.

The county has two branches of the Louisville and Nashville railroad, the Louisville, Knoxville and Atlanta, and the Cincinnati, Louisville and Norton; a total of about 40 miles of railroad. There is need for another railroad in the county which will compete and reduce the railroad rates on quarry products, coal, clay, etc., and there has been some rumor of an extension of the Southern Railway from Waynesburg or vicinity eastward and down Skaggs creek. The Rockcastle river is used to some extent for moving logs, cross-ties and tan-bark.

The principal towns are Mt. Vernon, Livingston, and Broadhead. Mt. Vernon, the county seat has about 750 inhabitants and is situated near the center of the county, on the Knoxville branch of the railroad. It has three churches, one newspaper, two banks, one industrial school for girls, one graded and high school, one roller mill, one saw mill, two quarries, one lime-kiln, two hotels, and twelve stores. Livingston is a division headquarters of the railroad and has 650 inhabitants, three churches, two saw mills, one school, ten stores, and a number of coal entries (now idle). Broadhead has three churches, one bank, one graded school, several stores, the county fair grounds, and about 500 people. Among villages there are Pinehill, Level, Green, Burr, Gum Sulphur, Goochland, Disputanta, Climax, Wildie, Mullins, Hansford, Quail, Conway, and Pongo.

The principal industries are farming, lumbering, and quarrying, and some mining. The population according to the 1910 census is 14, 473, an increase of 16.5 per cent. over 1900. With the proper building up of its industries, the increase should be much greater in the next ten years.

The following additional data largely from the 18th Biennial report of the Commissioner of Agriculture, Labor and Statistics (1908-9) is of interest:

"There are 72 public schools inclusive of one colored school; there is one sectarian industrial school for girls, and one high school. There are 41 churches, two banks, and one newspaper. There are 2735 white and 16 colored voters, and 5197 white and 24 colored children of school age. The total value of taxable property was: $1,493,905, and total taxes paid, $20,000. The rate of taxation is 97 cents per $100 and $1 for poll tax. The average value of farm land is given at $4.73 per acre. The number of live stock in the county having a total value of $334,079, is as follows: Horses 2420; mules 925; cattle 5810; sheep 2563; hogs 9602, while the value of farm and poultry products is about $125,000 per year. The number of acres under cultivation is given as follows: Burley tobacco 80, wheat 1938; corn 20,261; hemp 2; clover 866; and alfalfa 15.

"The county forms part of the 8th Congressional, 5th Appellate, 28th Judicial, 17th Senatorial and 70th Legislative districts."

Physiography and Topography.—The great interior plain of Kentcuky and what was part of the Cumberland plateau of Tennessee met in the west-central portion of the county. The Cumberland plateau escarpment was originally coincident with the western border of the Eastern Kentucky (Appalachian) coalfield. This plateau or the first peneplane originally described by M. R. Campbell and which according to him is possibly of Cretaceous age, is now only represented by a few high peaks and short ridges such as Linnville knob, Brushy mountain, Sutton knob, etc., which have an elevation of 1500 feet or more, the plateau having been dissected by the numerous streams owing to the softness of the sandstones of the Rockcastle series and the easy solubility of the underlying limestone so that in places it has been worn down a depth of 500 feet or more. The second peneplane has been described

by the same writer (U. S. Geological folio No. 47) as possibly of late Cretaceous or Eocane age, and is equivalent to the great interior plane of Kentucky, having originally an altitude of 1000 feet, but which the streams have cut down 100 to 150 feet in western Rockcastle county.

The divide between the Kentucky and Cumberland river drainages crosses in a northeasterly direction the northwestern part of the county. The Kentucky river drainage is represented by the head waters of Dix river and its branches, while Rockcastle river represents with its branches the Cumberland river drainage which covers about three-fourths of the county. The chief branches of Dix river are Copper creek, Nigger creek and East fork, while the chief branches of Rockcastle river, which forms the southeastern boundary of the county for more than 28 miles, are Line, Skaggs, Roundstone, and White Oak creeks and their branches. The chief branches of Roundstone, the largest stream within the county are Piney branch, Renfro, Clear, Brush and Crooked creeks.

The western half of the county is rolling except for occasional limestone and freestone knobs, the largest of which are Copper knob, Brushy mountain, and Sutton knob, which rise from 500 to 600 feet above the stream beds, the maximum elevation being at Brushy mountain which has an altitude of 1535 feet.

In the eastern half of the county, the sandstone formations of the Rockcastle series have maintained a higher general elevation, the most marked feature of which Big hill forms the dividing ridge between Madison and Jackson, and Rockcastle counties. Other prominent elevations are Scaffold Cane knob, Climax knob, Wolf branch knob, Elkins hill, Gauly and Wild Cat mountains, all except the last three having an altitude of more than 1500 feet.

Table of Altitudes.

The following altitudes are taken from Bull. 274, U. S. Geological Survey (1906) the authority therefore being, except where otherwise stated, the Louisville & Nashville Railroad:

	Feet
Broadhead	944
Brushy Mountain (U. S. G. S.)	1535
Conway	975
Langford	929
Linville Knob	1575
Livingston	889
Maretburg	1165
Mt. Vernon	1157
Mullins	904
Pinehill	1012
Sinks	929
Sutton Knob (U. S. G. S.)	1515
Wildie	928

Climate.—The climatological conditions as reported by the U. S. Weather Bureau for Richmond, Madison county which is just north of Rockcastle county will give a fair idea of the climate of Rockcastle county. Thus the normal monthly temperature and precipitation at Richmond is as follows:

	Jan.	Feb.	Mar	Apr.	May	Jun.	July	Aug	Sep.	Oct.	Nov	Dec.	Mean Annual
Temperature degeres F.	32.8	34.3	44.8	55.3	65.6	73.7	77.0	75.4	70.6	58.0	45.6	37.4	55.9
Precipitation Inches	4.23	3.55	4.62	3.39	3.38	3.57	3.69	3.18	2.39	2.49	2.95	3.64	Total Anunal 40.91

The number of rainy days reported for Richmond for 1909 was 132 although the average for the region is probably nearer 120 days. The killing frosts reported for 1909 for Berea (which is slightly nearer Rockcastle county than

Richmond), last in Spring, May 2, and first in Autumn, Oct. 12.

Agriculture and Soils.—Since Mr. S. C. Jones has in preparation a separate report on these subjects, they are not treated by the present writer.

Forest Conditions.—The following notes upon forest conditions of the county are from the report prepared by Messrs. J. S. Holmes and R. C. Hall of the U. S. Forest Service in co-operation with the State Bureau of Agriculture and published in the 18th Biennial report (1908-9) of the State Bureau:

Total area of county: 197,120 acres; Area forested 130,379 acres, or 66 per cent. Average stand per acre, board feet 1890 thousand feet; Total 246,425 thousand board feet. The thousand board feet of the various kinds of timber are given as follows: White oak, 31,750; Chestnut 22,976; Chestnut oak, 15,751; Black oak, 39,719; Maple, 8,828; Poplar, 17,703; Beech, 7,152; Hickory, 23,853; Yellow pine, 26,422; Gum, 24,207; Basswood, 7,257; Buckeye, 4,373; Ash, 3,905; Cucumber, 1725; Sycamore, 5, 317; Cedar, 1,858; Walnut, 1,927; Locust, 2,104.

The present annual output of timber for the county is given as follows: in thousand feet board measure: Logs 360; Lumber 4,550; Ties 4,377; Spokes 1,320; Handles 750; Staves 1,380; Poles 672; Posts 143; Cordwood 2,525; Shingles 130; Mining timbers 24; Total 16,231.

The following remarks are made on the county: "Until recently ehe making of staves has been the most important industry in this county, but this is supplanted to a large extent by cross-tie cutting, which takes smaller trees and is not confined to white oak. All species except pine, buckeye, poplar, and basswood are now cut for ties, the less durable kinds being subsequently treated with creosote. The spoke and handle industry has recently started in the county, and promises to make heavy inroads on the hickory and remaining white oak. Another means of rapid deforestation is the acid wood industry which utilizes chestnut down to the very smallest trees.

"The forests still occupy about two-thirds of the land, but thousands of acres have been so devastated by reckless logging and fire that there remains upon the ground nothing but a small growth of black and scarlet oak, pine and scattered hickory. The market conditions that favored this destruction are just as favorable to forest conservation, if the principles of forest management are intelligently applied. Since the young growth even of inferior species attains a market value in a short time, it should be protected from fire and grazing. As small timber even of inferior species can be handled with profit, cull and second growth forests can be greatly improved by thinning out the poorer trees. This gives the rest a chance to develop, and at the same time improves the stand by supplying seed of only the best species."

CHAPTER II

STRATIGRAPHY.

The surface of the county shows, owing to the southeasterly dip of the strata, beginning with the Corniferous limestone in the northeastern corner of the county, successively higher formations until the Corbin conglomerate is reached in eastern part of the county. Thus the only Devonian exposures are along Dick river and Copper creek, then almost half across the county, in a northeastern strip two to five miles wide as shown by the map, the Waverly sandstones and shales are the chief rocks capped on the highest points by the limestone series; still further east is a northeast strip of country three to four miles wide in which the limestones of the Upper Mississippian predominate and Waverly rocks are found only in the bottoms; thence eastward to the Jackson and Laurel county lines, the rocks of the Rockcastle series predominate, the highest ridges capped with the Corbin conglomerate, the valleys eroded into Upper Mississippian and where low enough even into Upper Waverlyan rocks. The details of distribution of the formation are shown on the county map.

The following section gives briefly the geological column which is followed by a more extended description of the several formations; that part of the section occurring below the Devonian and representing rocks under cover is that learned from the record of the Rockcastle county well near Mullen's station:

TABLE OF FORMATIONS.

Recent	Alluvium	Alluvium	0–30
Pennsylvanian Series.	Rockcastle Group	Corbin conglomerate Pinehill formation (with workable coals). Livingston conglomerate	45–105 330 22–89
Mississippian Series.	Chester Group	Unconformability of erosion and dip. Leitchfield formation Tribune limestone	 50–129 25–31
	Ste. Genevieve	Ste. Genevieve limestone	91–130
	St. Louis Limestone	Unconformability of erosion. Mullins member Unconformability of erosion. Orlando member	 22–49 47–57
	Keokuk	Unconformability of erosion. Keokuk limestone	 12–35
	Waverly Group	Unconformability of erosion. Upper Waverlyan formation Cuyahoga formation	 9–55 287–358
Devonian	Ohio shale Corniferous	Unconformability of erosion and ?dip. Ohio shale Corniferous limestone	 60–150 10–20
Silurian	Under cover: Niagara Clinton	Unconformability of erosion. Crab Orchard shale Brassfield limestone;	 19–30 18
Ordovician	Cincinnatian	Richmond-Maysville formation (shaly, blue limestone) ?Garrard sandstone (sandy limestone) Eden formation (thin crystalline limestones)	280 90 200
	Mohawkian	Lexington limestone (gray crystalline) Tyrone limestone (white lithographic)	150

Devonian.

There is but a small area in northwestern and western Rockcastle county where Devonian strata are brought to the surface by the rising dip. Some prominent outcrops of the Ohio Black shale occur, but of the underlying Corniferous limestone no good sections are to be had in outcrop, so that to learn its thickness and character it is necessary to depend on sections in eastern Lincoln and southwestern Madison counties. Its economic products are the shale and limestone. From these the following section is generalized:

GENERAL SECTION OF DEVONIAN.

	Feet
Ohio shale: Black fissile carbonaceous slate	60–150
Corniferous limestone: includes brecciated (Duffin) layer at top with magneisan limestone below	10–20

Mississippian Series.

This consists beginning with the lowest, of the Waverly, Keokuk, St. Louis, Ste. Genevieve and Chester groups. It becomes possible for the first time to properly classify the limestone and shales of this series occurring above the Waverly group, as heretofore they were grouped under such indefinite names as Pennington shale and Newman limestone, Maxfield limestone, Chester, St. Louis, etc. The Waverly group supplies freestone and shale, while the remaining groups furnish limestone and shale for varied purposes (see Part II).

Waverly Group.

The Waverly group has a thickness of 350 feet and may be divided tentatively into two divisions. 1. The Upper Waverlyan formation including the strata between

the Keokuk-Waverly unconformability and the base of the sandstone member which includes a workable freestone ledge which ledge may be called the Hummel bed. 2. The Cuyahoga formation consisting of the calcareous, clayey, and sandy shales (containing clay iron stone concretions) and slaty sandstone, occurs between the sandstone member at the base of the Upper Waverlyan, and the top of the Ohio shale. The basal shales of the Cuyahoga are calcareous and contain here, as usual, the phosphatic nodules. The Bedford, Berea, and Sunbury formations which form the lower part of the Waverly group further north have thinned coming southward until in northern Rockcastle county they are absent. The exact top of the Cuyahoga must remain uncertain until more extended studies have been made of this formation in Ohio and Kentucky, and until then also, must be delayed the final naming of the Upper Waverly beds.

There follows a generalized section of the group:

GENERALIZED SECTION OF WAVERLY GROUP.

	Feet.
Unconformability of erosion.	
Upper Waverlyan formation:—9 to 55 feet.	
Dark green sand (sometimes sandstone) 3 to 4 inches	.....
Sandy to clayey gray shale	11–22
Green or green and purple shale	0–2
Brown umber-like shale	0–2
Calcareous sandstone containing quartz geodes and *Spirifer, Seminula,* etc., 9 inches to	1–2
Fine-grained clayey, slaty to solid sandstone beds, including the Hummel bed, 6 to 9 feet of good freestone; the lower beds show worm casts	8–43
Cuyahoga formation:—287 to 358 feet.	
Sandy shale containing clay-ironstone concretions, and partly iron seamed	59
Slightly clayey, slaty sandstone, sometimes with iron concretions	30–39
Covered, partly shale	26–32
Slaty sandstone	0–16
Sandy ferruginous shale containing clay-ironstones, partly iron-seamed	106–110
Slaty sandstone and sandstone shale	24
Gray to blue calcareous clayey shale with phosphatic nodules at the base	43–80

Keokuk Limestone.

This limestone is thin and consists chiefly of clayey magnesian limestones and marly shales; it terminates above in a conglomeratic, usually calcareous, sandstone, and below by a deep green sand or sandstone which occurs at the unconformability at the top of the Waverly group. The quartz geodes of the Keokuk limestone are common to it here just as in the Mississippi valley. This limestone is partly equivalent to the Harrodsburg limestone of Indiana. A generalized section follows, the thickness varying from 12 to 35 feet:

GENERALIZED SECTION OF KEOKUK LIMESTONE.

Argillaceous limestones wirh large geodes, alternating with some calcareous shale; usually at the top although sometimes absent about five feet of calcareous sandstone, (Atherton bed) the upper part of which is a small pea-sized quartz conglomerate.....12 feet 6 inches to 34 feet 10 inches.

Erosion unconformability with three-inch green sand at the top of the Waverly.

St. Louis Limestone.

The St. Louis limestone is divided into two members by an erosion in conformability which is also a marked water horizon; the upper member characterized by predominant blue compact cherty limestones may be called the Mullins member after the railroad station of that name four miles north of Livingston in Rockcastle county where there is a good section of it exposed. The lower member consisting chiefly of clayey limestones is well exposed at and near Orlando, hence the name Orlando member. The Mullins member terminates above in a conglomerate of irregular flint particles with limestone cement, while the Orlando member is separated from the Keokuk below, which it resembles considerably lithologically by a conglomerate, usually calcareous, sandstone which is usually

but not always present. Furthermore the Orlando member is further distinguished by the absence of large quartz geodes. Both members of the St. Louis have the characteristic reed-like corals called Lithostrotion, also Archaeo cidaris spines Zaphrentis calciformis, etc.

The following is a good generalized section of this group, which is from 70 to 106 feet thick:

GENERAL SECTION OF ST. LOUIS LIMESTONE.

Erosion unconformability.

Mullins member:—22 feet 3 inches to 48 feet 9 inches.

Compact to semilithographic blue limestone alternating with some crystalline and shaly limestone; many of the beds contain abundant flint concretions and *Lithostrotion proliferum* and *L. canadense*; at the top there is usually a flint conglomerate (transition bed) and at the base a crystalline semi-oolitic fossilliferous limestone.

Erosion unconformity: strong spring horizon.

Orlando member:—46 feet 7 inches to 56 feet 11 inches.

Argillaceous and magneisan limestones, lower beds have green markings, with two thin compact blue limestone beds, the lower of the beds containing *Lithostrotion proliferum*, *Archaeocidaris*, etc., little or no shale.

Ste. Genevieve Limestone.

This group like the preceding is marked above and below by unconformabilities of erosion (the top one being slight) and besides includes numerous unconformabilities of lesser extent. It is readily divisible into four distinct members, two compact alternating with two characteristic oolitic terranes. The oolitic beds are named Sparks and Mt. Vernon beds respectively, after Sparks quarry and Mt. Vernon where each is most marked. The compact member above the Sparks bed resembles the Ohara limestone, carrying Ohara fossils while the Sparks and remaining beds equal the Fredonia member of Western Kentucky. The fossils are those characteristic of this formation in western

Kentucky, the most common being *Pentremites florealis*. A generalized section of the group follows, the thickness varying from 91 to 130 feet.

GENERAL SECTION OF STE. GENEVIEVE LIMESTONE.

	Feet	In.
Erosion unconformability.		
Green sandy shale, 0 to	1	0
Compact limestones, usually more or less magnesian, brecciated at the top with occasional crystalline and laminated fossiliferous layers, 7 feet 10 inches to	22	9
Sparks bed: White oolitic limestone with thin compact, usually magneisan partings, numerous stylolitic (crow's feet) planes, 11 feet 6 inches to	30	0
Compact to semilithographic limestone, thin flint bands near the top and upper part sometimes brecciated, 6 feet 2 inches to	15	8
Mt. Vernon bed: White to gray oolitic limestones with numerous stylolitic planes, 7 feet 3 inches to	19	6
Dark oolitic limestone, some beds more siliceous than others with one or more cross-bedded terranes, compacted brecciated limestone at the top, 45 feet to	74	0

Chester Group.

Beginning and ending with unconformabilities of erosion, this group varies in thickness from 0 to 150 feet, and consists of two well marked formations, the Leitchfield formation and the Tribune limestone. The Leitchfield formation includes the varicolored marly shales and thin limestones heretofore designated by Mr. M. R. Campbell the Pennington shale together with the underlying ferruginous limestones which are characterized by the typical Leitchfield fossils of western Kentucky. For discussion of the use of the term Leitchfield reference should be made to Bulletin 16, Chapter III. The Leitchfield varies from 50 to 129 feet thick. The Tribune limestone which is next below, is from 25 to 31 feet thick and includes semi-oolitic, oolitic and crystalline beds, the uppermost of which are easily recognized by the large (usually silicified) crinoid stems, and the base by the green sandy shale at the top of the Ste. Genevieve limestone. The lowest or pentremital bed is suggestive of the Holly limestone which separates the two lowest sandstone members in Breckenridge county, and further studies may possibly prove it the same. The base of the Tribune in Rockcastle county is a marked water horizon.

The Chester group, however, differs in one respect considerably from its character west of the Cincinnati anticline, and that is in the absence of sandstone members separating the limestone members. Thus, aside from a few thin sandstone beds in the shale at the top of the Leitchfield no sandstone occurs in the Chester in Rockcastle county; on the other hand, the limestone beds maintain both the lithologic and faunal characters common to them in western Kentucky.

There is given herewith a generalized section of the group:

GENERAL SECTION OF CHESTER GROUP.

	Feet	In.
Leitchfield formation: maximum thickness	128	8
Red, green, and black shale with thin intercalated layers of sandstone and limestone, the latter with abundant *Archimedes, Pentremites pyriformis, P. foshi*, etc.; these shales are usually wholly or nearly absent; probably complete section	73	8
Granular, crystalline, and siliceous oolitic, slightly fossiliferous limestones, the lower beds blue and slightly bituminous; beds slaty and yellowish-brown on weathering, 17 feet 3 inches to 30 feet 6 inches, average	22	0
Gray to greenish gray shale including one bed of fossiliferous limestone, 10 feet 8 inches to 17 feet, average	11	0
Fine to coarse crystalline limestone, more or less fossiliferous, containing *Pentremites pyriformis, Agassizocrinus conicus, Pterotocrinus spines, Zaphrentis spinulifera*, etc., lower beds often oolitic with a fossiliferous shale or shaly limestone at the base, 20 to 26 feet 4 inches, average	22	0
Tribune limestone: 24 feet 8 inches to	31	1
White coarsely crystalline semi-oolitic to oolitic with occasional thin chert fragments, contains abundant large crinoid stems, conical crinoid bases, and horn-shaped corals (these fossils silicify on weathering), 20 to	25	0
Fine-grained crystalline siliceous limestone, 0 to	1	9
Gray crystalline to coarse-crystalline limestone, somewhat compact near the base; contains abundant *Pentremites pyriformis*, 3 feet to	4	0

PENNSYLVANIAN SERIES.

Rockcastle Group.

The Rockcastle group forms the basal member of the Pennsylvanian series and covers all of that series exposed in the county. This group consists of a variable series of shales, sandstones, conglomerates, and coals; there are three of the coals fairly presistent and locally of workable thickness. The conglomerates, as is usually the case elsewhere, are extremely irregular in thickness, thickening and thining and being replaced by sandstones or shales; two marked erosion unconformabilities exist which partly explain the extreme variations in thickness. One of these occurs at the base of the series, which rests on members of the subjacent limestones series varying from the Ste. Genevieve limestone to the top of the Leitchfield formation; the other unconformability occurs at the base of the Corbin conglomerate. The Rockcastle group has a thickness of 450 feet; and attempt is made below to show the average sequence of its strata, an attempt in which there are many inherent difficulties as will be appreciated by anyone who has studied the conglomerate series in eastern Kentucky. However, a large number of detailed sections were obtained (only the best of which are presented in this report) and from a careful analysis of them, the generalized section was deduced. By its use, it is believed the position of the coals in any particular part of the county can be fairly well placed without direct reference to the uncertain (highly unconformable) limestone horizon below. This group gives rise to a much broken topography.

The name Rockcastle group was given by Prof. A. R. Crandall, and has priority over Mr. M. R. Campbell's term Lee formation. Mr. Campbell called the lowest conglomerate "Rockcastle" but this name, it is evident, was pre-

occupied. Prof. A. M. Miller applied the name Livingston" to the conglomerate seen at the town of that name, and the name is here retained but defined to include all the strata below the Livingston coal and above the unconformability at the top of the Mississippian series; the Livingston conglomerate where well developed consists of two conglomeratic members separated by a shale member. The Corbin conglomerate, the uppermost formation of the group, was named by Mr. Campbell and is retained. For the members between the Corbin and Livingston conglomerates, the name Pinehill formation is here proposed; this includes the three principal coals, and between the lower two coals there is at times a conglomerate developed which has been confounded heretofore with those below the Livingston coal. Since the equivalency to the Hudson, Beaver Creek, and Barren Fork seams of the coals to which the local names Livingston, New Livingston, and Corley Hollow are applied, appears an open question, it is deemed best to use tentatively the local names. Thus the Livingston coal is that of the double vein worked immediately above the tracks at Livingston (whether this or the New Livingston is the coal that Prof. Norwood called "Livingston" is uncertain); the New Livingston coal is the next higher workable bed which was extensively mined at the New Livingston mines immediately across the Rockcastle river from Livingston, while the Corley Hollow coal is the highest workable coal of the Pinehill member and was extensively operated in the vicinity of Pinehill, and especially to the south about one mile and a half at head of Corley Hollow, hence the name. The position of the New Livingston seam corresponds to that of the Beattyville coal in Lee county, but its exact equivalency has not been established. The economic products are coal, fireclay, conglomerate, shale and sandstone; see part II.

There follows a generalized section of this group:

GENERALIZED SECTION OF ROCKCASTLE GROUP.

		Feet	Inches
Corbin conglomerate: The upper 40 feet consist principally of conglomeratic beds, and the lower 60 to 75 feet consists of friable, pink-colored, coarse-grained, micaceous, iron seamed sandstone with occasional alternating conglomerate layers which are frequently highly ferruginous; the pebbles are small, usually pea-sized. Thickness 45 to 105 feet, average		72	0
Marked unconformity.			
Pinehill formation; Thickness about 330 feet.			
40–115 feet	Shale with thin beds of intercalated sandstone, rarely a thin coal at base, 0 to 120 feet, average	60	0
	Laminated to massive cross-bedded sandstone, 0 to 58 feet, average	26	0
	Black slate, 0 to 30 feet, average	5	0
Corley Hollow Coal: Hard splint coal, sometimes softer near the top, contains a little sulphur, and may have a few inches of draw slate; in Pinehill-Livingston region 30 to 32 inches and in Brush Creek-Billows region 54 to 85 inches; hence usually		0	30–55
131–158 feet	Shale, fireclay, or ganister rick, 0 to 8 feet, average	5	0
	Sandy argillaceous shale containing occasional layers of iron "boxes", 0 to 65 feet, average	40	0
	White to dark, fine-grained, slaty, laminated, or massive sandstone, 10 to 24 feet, average	15	0
	Coal	0	2–6
	Drab to yellowish shale with thin sandstone layers and sometimes a few inches of coal, 15 to 64 feet	40	0
	Slaty or laminated sandstone, 3 to 31 feet	10	0
	Drab shale more or less iron seamed with usually 15 to 24 inches of hard sandstone at the base. 5 to 50	25	0
	Black slate, 5 to 10 feet	5	0
	Plastic fireclay or occasionally firesand instead, present only when coal is thin, 20 to 60 inches	3	0
	Cannel slate usually with more or less pyrite in layers and seams, present when fireclay is absent; seen only in the region between Mount Vernon and Hansford 0 to	0	25
New Livingston Coal: Good splint with a little "sulphur", upper part rarely cannel; a thin parting in one instance; south of Mt. Vernon and in vicinity of Livingston usually from 19 to 36 inches thick, but between Mt. Vernon and Pinehill and south of the latter place it is from 8 to 18 inches thick; average		0	24
58–85 feet	Plastic fireclay, 32 to 72 inches at Pinehill and to the south and west, elsewhere 0 to 24 inches	2	
	Coal, thin, rarely present	.....	.....
	Firesand (ganister rock) with stigmarine, 0 to 6 feet	4	0
	Shale, sandy slate or laminated sandstone, 14 to 46 feet, usually	20	0
	Hard fine-grained sandstone with plant impressions, 0 to 16 inches	1	0
	Micaceous siliceous slate or shale with iron seams; sometimes absent; 0 to 27 feet, usually 7 to	18	0
	Coal, usually covered or absent, 0 to	0	16
	Slaty to massive sandstone, sometimes partly conglomeratic (large pebbles) some beds bituminous and cavernous, 0 to 65 feet, usually 20 to	25	0
	Gray to black sandy, micaceous, slightly ferruginous shale containing pyritious niggerheads, 0 to 6 feet	5	0

GENERALIZED SECTION OF ROCKCASTLE GROUP—Continued.

		Feet	In.
Livingston coal: Hard splint coal, usually free from "sulphur", 9 to 36 inches, average		0	20
Gray to black fireclay or shale, 6 to 54 inches, usually less than but averages		0	21
Coal, usually soft, rarely cannel, 6 to 36 inches		0	16
Livingston Conglomerate:			
22–89 feet	Fireclay, 18 to 42 inches	2	0
	Coarse-grained or slaty sandstone with or without conglomerate (large pebbles) beds intercalated 8 to 30 ft.	20	0
	Coal, 0 to	0	20
	Shale with iron seams or black slate, with thin sandstone and conglomerate layers, also including at times a ferruginous limestone, 4 to 5 feet thick and clay ironstone concretionary layers; 20 to 27 feet thick; often absent from lack of deposition	20	0
	Laminated and massive coarse-grained sandstone alternating with conglomerate layers (large pebbles); often absent from lack of deposition, 10 to 38 feet	10	0
	Unconformity of erosion and dip.		

DETAILED SECTIONS.

Devonian Silurian.

Section 5½ miles S. W. of railroad station at Berea, ¾mile east of Cartersville, east of White Lick Creek by August F. Foerste. (From Bull. 7, p. 161).

	Ft.	In.
Phosphatic nodules ½ inch long, at base of the Waverly	.....	.....
Black shale, no account taken of the dip, the amount of which is not known	102	0
Sandy rock	0	6
Brown brecciated or Duffin layer, apparently faulted and otherwise disturbed so that its original thickness is uncertain	11	0
Crab Orchard bed, upper part consisting of lower part of Alger clay, probably with Plum creek clay bed at base	19	0
Thin limestone interbedded with clay	4	0
Solid limestone with *Whitfieldella*	1	6
Limestone with large crinoid beads *Cyathophyllum calcyculum*, and *Zaphrentis daytonensis*	0	6
The remainder of the Brassfield bed consists of reddish brown limestone	12	0
Top of Ordovician.		

Waverly Group.

SECTION AT COPPER CREEK HILL.

	Ft.	In.
Keokuk limestone:—21 feet 4 inches.		
Limestone waste and covered to top of hill	21	4
Waverly Group:—324 feet.		
Upper Waverlyan	37	2
Soft, gray, sandy shale	5	4
Gray sandy slate	11	0
Gray slightly sandy shale	5	6
Deep green shale (usually top of Waverly)	0	6
Brownish umber-like shale	0	6
Covered interval	1	0
Clayey sandstone, weathers slaty, upper part contains quartz geodes and upper one and one-half inches is fossiliferous	13	4
Cuyahoga formation:—286 feet 10 inches.		
Sandy shale, upper ten feet harder	17	0
Gray slightly sandy shale, darker toward top, and has iron seams and clay iron stone concretions	41	8
Slightly clayey laminated to slaty sandstone, hummocky at the top, iron stained and greenish	12	6
Slaty sandstone rather compact at base	13	0
Sandstone, breaks somewhat into slate	3	0
Slaty sandstone with occasional three-inch solid layers and larger layers weathering into slate	9	5
Clayey ferruginous sandstone	1	9
Covered interval	26	2
Slightly sandy ferruginous shale, containing clay iron stone concretions and iron seams, more sandy at top	58	8
Covered interval	21	0
Sandy shale	16	0
Slaty sandstone	13	1
Sandstone shale	10	8
Blocky sandstone with iron seams	0	3
Gray shale hardening toward top	21	4
Gray shale (in well) water obtained one foot above base below a three-inch sandstone	21	4
Ohio black slate to Copper Creek	10	8

UPPER WAVERLYAN SECTION AT HUMMEL.

	Ft.	In.
Keokuk limestone:—6 feet.		
Covered and waste	3	0
Limestone with quartz geodes	3	0
Unconformability of erosion	..	..
Upper Waverlyan:—47 feet 1 inch.		
Deep green shale	0	3
Greenish knotty, slaty sandstone with quartz geodes	0	9
Fine-grained clayey sandstone, beds usually slaty, rarely compact, each 5 to 24 inches thick	12	1
Hummel bed:—Fine-grained clayey sandstone, good quality freestone, 6 to	9	0
Fine-grained, clayey sandstone beds alternating with thin layers of shale	8	6
Fine-grained, clayey sandstone, slaty and solid beds alternating	5	6
Slaty sandstone weathering to slate	11	0

SECTION OF STE. GENEVIEVE, ST. LOUIS, AND KEOKUK LIMESTONES AT BIG HILL NEAR THE JUNCTION OF ROCKCASTLE, JACKSON AND MADISON COUNTIES.

	Ft.	In.
Ste. Genevieve limestone:—		
Fossiliferous slaty limestone, brecciated at the top	5	6
Sparks bed: White oolitic limestone	9	0
Compact crystalline limestone, slaty at the top	4	0
Compact limestone	4	0
Magnesian limestone	1	3
Mt. Vernon bed: Gray oolitic limestone containing *Pentremites florealis*	3	6
Covered interval including some compact limestone	10	11
Dark oolitic limestone including a compact bed	18	0
Compact semilithographic limestone, brecciated at the top and joined to the beds below	13	0
Fine laminated gray oolitic limestone (3267)	8	0
St. Louis limestone:		
Mullins member:		
Oolitic limestone containing fragments of pink flint and *Lithostrotion proliferum*	1	9
Calcareous red flint conglomerate, partly covered	1	6
Compact limestone containing abundant flint nodules and *Lithostrotion canadense* in upper one foot and *L. proliferum* below; (3281), 7½ to	8	0
Crystalline fossiliferous limestone with thin green shale layers between the beds	4	0
Orlando member:		
Unconformability of erosion; water horizon.		

SECTION OF WAVERLY GROUP AT BIG HILL, MADISON COUNTY.

(where the state road approaches the junction of Madison, Rockcastle, and Jackson counties.)

	Ft.	In.
Keokuk limestone.		
Waverly group:—366 feet 2 inches.		
Upper Waverlyan:—8 feet 4 inches.		
Alternate slaty and solid beds of freestone	8	4
Cuyahoga formation:—357 feet 10 inches.		
Covered interval (perhaps partly upper Waverlyan)	56	4
Sandstone	2	0
Shale	0	6
Slaty sandstone with iron concretions	30	0
Sandy shale	5	4
Covered interval	26	8
Slaty sandstone	16	0
Gray sandy shale	10	8
Clayey sandstone shale with clay ironstones	21	4
Gray shale with clay ironstone concretions (Sample 2)	13	0
Gray shale, partly covered	21	4
Covered interval	74	8
Greenish shale with clay ironstone concretions	42	8
Covered interval	21	4
Gray shale with phosphatic nodules	16	0
Ohio shale:		
Black slate at foot of Big Hill	..	..

Ste. Genevieve Limestone.

GENERALIZED SECTION IN VICINITY OF MT. VERNON, 114 to 130 Ft.

No.		Ft.	In.
	Erosion unconformability.		
30	Green sandy shale, 0 to	1	0
29	Dark gray brecciated compact limestone with green sandy clay cement which weathers to reddish brown (3271), 3 ft. 10 in. to	6	0
28	Light gray oolitic limestone, 0 to	4	0
27	Laminated compact limestone (3272) 0 to	2	6
26	Compact ?magnesian limestone (3273) 4 to	3	6
25	Gray coarse crystalline limestone (3274) 0 to	1	10
24	Dark compact magnesian limestone, used for lime, slakes slowly, (3292), 0 to	1	7
23	Gray compact probably magnesian limestone with calcite facets (3276) 0 to	3	4
	Sparks bed:—11 feet 6 inches to 30 feet thick.		
22	White oolitic limestone, 0 to	6	0
21	Compact magnesian limestone, weathers yellow, 0 to	0	8
20	White to gray oolitic limestone (3277) 2 ft. 6 in. to	9	6
19	Dark compact crystalline limestone (3278) 2 in. to	1	0
17–18	White crystalline oolitic limestone with 14 or more stylolitic planes (3280) 9 ft. 5 in. to	12	5
16	Dark oolitic limestone, 0 to	1	10
15	Semilithographic limestone, upper layers brecciated and upper half has half-inch flint bands; sometimes has wavy bitumen seams, (3279) 11 ft. 7 in. to	5	6
14	Green shale 0 to	0	2
13	Compact blue-gray oolitic limestone, 3 ft. 9 in. to	3	0
12	Semi-lithographic to semi-compact limestone, upper part sometimes brecciated, 0 to	6	3
11	Green shale, 0 to	0	2
10	**Mt. Vernon bed**:—White crystalline to fine-grained, with stylolitic planes, 4 to 12 inches apart (3282), (lower four feet light pink at the Sparks quarry (3283)); has occasional small flint nodules, calcite concretions, and lenses of blue oolite, most beds being free of these. Sometimes these beds are split by a 6- to 8-inch magnesian limestone (Kruger quarry 3288), 8 feet to 19 feet 6 in. to	17	10
9	Dark oolite, partly compact limestone, (3275) 0 to	0	8
8	Dark compact limestone breccia, sometimes thin beds (3284)	3	6
7	Yellowish compact magnesian limestone, 0 to	3	0
6	Dark oolitic limestone with some flint nodules, horizontal bedding, (3285)	5	6
5	Dark banded oolitic limestone, 3- to 15-inch beds, cross-bedding marked (3287), 7 ft. 11 in. to	7	0
4	Greenish sandy-shaly limestone	0	2
3	Dark oolitic limestone, some sandy-clay patches, horizontal bedding, (3286)	3	9
2	Gray siliceous oolitic limestone, upper part having sandy-clay patches, uppermost 2½ inches a flint conglomerate (3286)	5	5
1	Dark banded oolitic limestone, some cross-bedded terranes, about	45	0

SECTION OF STE. GENEVIEVE LIMESTONE ALONG RAILROAD BETWEEN SINKS AND MULLINS.

		Ft.	In.
	Ste. Genevieve Limestone, 113 feet 3 inches.		
	Unconformability of erosion.		
20	Brecciated compact limestone	4	0
19	Magnesian limestone, 2 beds	5	10
18	Laminated limestone	1	3
17	Dark gray, semi-crystalline oolite	0	10
16	Compact limestone	0	9
15	Fine granular crystalline limestone, probably magnesian, weathers yellow and clayey	4	7
14	**Sparks bed**:—White oolitic limestone (3263)	9	8
13	Yellow magneisan limestone 6 to	0	8
12	Semi-oolitic crystalline limestone 3 inches of oolite at top	2	9
11	Greenish shale 2 to	0	4
10	Semi-lithographic limestone with flint bands	2	6
9	Light colored semilithographic limestone	2	2
8	Dark compact limestone	0	10
7	Crystalline to compact limestone	0	4
6	**Mt. Vernon bed**:—Gray fine-grained oolitic limestone	5	0
5	Magnesian limestone	1	0
4	Blue fine crystalline limestone	1	3
3	Dark fine-grained oolitic limestone slightly siliceous (3260).	16	0
2	Dark oolitic cross-bedded limestone (3260)	4	6
1	Dark oolitic limestone, slightly siliceous with increasing cross-bedding, with pink flint and a 6-inch bed of chert in the lower part, large Spirifers at base (3261)	49	0
	Unconformability of erosion.		

	Ft.	In.
Clayey limestone brecciated and cemented with brown calcite at the top; much weathered	10	4
Semilithographic limestone, brecciated at the top; includes one inch of shale at base; 1 ft. 6 inches to	1	0
Clayey limestone, soft and hard beds alternating, including six inches of shale; soft beds weathering to clay	10	6
Clayey sandstone with some thin shale layers	5	5
Calcareous clayey sandstone and shale layers containing a bryozoan	1	10
Green shale; water horizon	1	0
Compact clayey limestone, 2 to	3	0
Covered interval, probably shaly limestone	2	6
Clayey limestone with green markings (3264 covers 32 feet up)	7	0
Keokuk limestone:—		
Clayey compact limestone with thin shale at top (3262)	12	6
Waverly sandstone below.		

St. Louis Limestone.

SECTION OF MULLINS MEMBER OF ST. LOUIS LIMESTONE AT MULLINS; 22 FEET 3 INCHES TO 29 FEET 9 INCHES.

	Ft.	In.
Unconformability of erosion.		
Flint breccia	0	1
Semilithographic limestone	4	0
Granular crystalline grading into compact limestones	6	2
Breccia of semilithographic limestone fragments cemented with coarser lighter gray limestones	3	4
Dark gray lithographic limestone, many flaws and iron seams, lower 1 ft. has many small crystals, 2 ft. 2 in. to	2	10
Lense consisting of shale and magnesian limestone, 1 ft. 6 in	2	10
Crystalline limestone and soft breccia, 1 ft to	2	0
Concretions, containing abundant *Lithostrotion proliferum*, 4 ft. 9 in. to	5	4
Grayish-white crystalline semioolitic limestones with abundant fossils thin greenish shale at top and between beds, 4 ft. 10 in. to	5	2
Unconformability of erosion	5	2

GENERALIZED SECTION OF ST. LOUIS LIMESTONE ON THE BROADHEAD ROAD, WITHIN FOUR MILES OF MT. VERNON; THICKNESS 98 FEET 9 INCHES TO 105 FEET 8 INCHES.

	Ft.	In.
Unconformability of erosion.		
Mullins member:—42 feet 9 inches to	48	9
Conglomerate consisting of small angular flint fragments cemented with crystalline limestone, upper 12 inches especially conglomerate	2	6
White crystalline limestone with *Spirifer leidyr*, *Bellerophon*, etc., which silicify on weathering, containing a chert layer 1 to 8 inches thick, 18 inches from the top, 1 ft. 6 in. to	3	10
Semi-compact to semi-lithographic limestones with flint bands in upper part and a flawed lithographic bed near the base 4 to	7	8
Crystalline to semioolitic limestone	5	6
Compact to semi-lithographic limestone with flint concretions, abundant toward the middle and pink colored near the base, *Lithostrotion canadense* horizon, about	12	0
Covered interval	2	0
Semi-lithographic limestone with a gastropod similar to *Naticopsis*	2	0
Partly crystalline compact limestone with flint concretion and abundant *Lithostrotion proliferum*, *Spirifer leidyr* at base, about	5	0
Partly crystalline compact limestone, lower 17 in. contains medium sized crinoid stems, about	5	9
Shale and shaly crystalline limestone, lower 18 inches has abundant bryozon, etc	2	6
Orlando member, 56 to 56 feet 11 inches.		
Yellow compact magnesian limestone cemented with calcite seams	4	0
Covered interval with argillaceous shaly limestone at base, about	6	0
Covered interval with hard argillaceous magnesian limestone at the top, about	5	0

(CONTINUED.)

	Ft.	In.
Yellow compact magnesian limestone	2	0
Yellow siliceous argillaceous magnesian limestone, about	4	0
Compact brecciated limestone with ferruginous-calcite cement	0	10
Covered interval, partly magnesian limestone	2	0
Magnesian marble 2 to	0	3
Compact limestone with calcite grains, about	0	8
Lithographic limestone, much calcite seamed, and containing chert, 6 in. to	1	3
Compact brecciated limestone	0	6
Argillaceous limestone with 4 inches of brownish marble 8 inches below top	5	11
Greenish-gray shale	0	6
Argillaceous limestone with brown calcite seams	3	10
Compact limestone	0	8
Compact blue limestone containing *L. proliferum* and *Syringofora*	1	0
Argillaceous limestone with *L. proliferum*, soft and yellow when weathered, usually attached to bed above	0	6
Compact limestone	0	6
Sandy limestone, 6 to	0	8
Shaly limestone with *Zaphrentis calciformis*	0	6
Fine granular magnesian limestone containing some flint nodules, and has small pyrite seams at the top	7	3
Fine granular limestone with green markings, especially marked in basal 12 inches, and containing calcite geodes in upper beds	4	7
Yellow calcareous clay, partly covered	2	4
Yellow clayey limestone with geodes at the top	2	0

Keokuk Limestone.

SECTION ON THE BROADHEAD ROAD, ABOUT FOUR MILES FROM MT. VERNON.

	Ft.	In.
Keokuk limestone, 34 feet 10 inches.		
Limestone containing coarse sand grains, with a green sand at the top, which in places is a small pea sized conglomerate 8 inches thick, and immediately below which the limestone is partly compact, brecciated, and cemented with calcite; it contains occasional argillaceous limestone masses, large crinoid stems and *zaphrentis* silicified and large quartz geodes	5	6
Gray shale 6 in. to	1	6
Ferruginous shaly limestone with a little quartz and flint	1	0
Greenish argillaceous shale	5	4
Yellow shaly magnesian limestone, lower 8 in. covered, perhaps shale	2	4
Yellow magnesian limestone, containing large quartz geodes, especially abundant 3 feet from the top	5	0
Covered interval	1	9
Magnesian limestone with occasional large quartz geodes	5	4
Covered interval	0	10
Argillaceous magnesian limestone with geodes at the top	2	6
Covered interval	2	1
Argillaceous magnesian limestone with large quartz geodes, shaly at the top	1	8
Covered interval containing unconformability of erosion and top of Waverly which is a three inch deep green sand.		

Chester Group.

SECTION ON HILL IMMEDIATELY SOUTH OF MT. VERNON.

	Ft.	In.
Covered interval to top of hill	19	0
Leitchfield formation:—70 feet 6 inches.		
Fossiliferous limestone, 6 to	0	8
Marl	1	8
Laminated limestone contains *Spirifer setigera, Spirifer leidyr, Cleiothyris roissyi, Pentremites fohsi, Pterotocrinus, Zeacrinus maniformis, Archimedes swallovanis, A. terebriformis*, etc.; 1 foot 6 inches to	2	0
Marl	3	4
Blue to gray coarsely crystalline limestone, upper layers slightly ferruginous with *Zaphrentis spinulose, Pentremites pyriformis*, large *Producti*, etc., 22 feet to	28	6
Blue coarsely crystalline, slightly bituminous, and shaly fossiliferous limestone	2	0
Marl, 1 foot 7 inches to	3	4
Limestone, 1 foot to	0	6
Dark gray marl, 8 feet 5 inches to	6	7
Blue-gray fine to coarse-crystalline limestone which weathers brown	10	8
Blue, iron-stained compact crystalline limestone containing *Zaphrenti*	1	5
Coarsely crystalline limestone contains small crinoid stems and *Productus cestriensis*	1	6
Blue-gray coarse-crystalline	1	6
Shale	0	5
Compact semi-crystalline limestone	0	6
Shale	0	8
Compact crystalline laminated limestone contains *Spiriferina transversa* and *S. norwoodana*	3	0
Limestone with *Agassizocrinus conicus*, 12; green shale, 4; and shaly limestone 8 inches; or shale	2	3
Tribune limestone:—26 feet 8 inches.		
Coarsely crystalline white oolitic limestone contains large crinoid stems, *Zaphrenti, Agassizocrinus conicus* with gastropods 1½ to 2 inches at top	26	4
Shale	0	4

SECTION OF UPPER PORTION OF LEITCHFIELD FORMATION AT BILLOWS.

	Ft.	In.
Gray shale	1	8
Purplish-red shale	3	8
Hard ochre	0	8
Greenish shale	1	9
Red shale	1	0
Greenish-gray shale	5	4
Greensih shale with slaty sandstone at the top, containing one foot at bouldery limestone partly weathered to umber	3	0

(CONTINUED.)

	Ft.	In.
Purplish-red shale	2	6
Darker shale	1	4
Slaty sandstone	0	4
Reddish shale	3	8
Greenish slaty sandstone	0	5
Purplish-red shale	1	6
Covered interval	20	10
Black shale	4	0
Semi-compact ferruginous limestone, fossiliferous	7	6
Greenish shale	10	6
Impure yellowish limestone	1	0
Gray marl	3	0
Limestone with *Archimedes* (Probably third bed of Leitchfield)	2	6

Rockcastle Group.

GENERAL SECTION OF HILL BETWEEN MT. VERNON AND BURR.

	Ft.	In.
Pinehill formation:—113 feet.		
Covered to top of hill, chiefly shale, about	20	0
Pink sandstone	17	3
Shale with iron seams, with 3 inches sandstone at base, 0 to	5	0
Shale with 2 inches coal, 0 to	0	8
Hard sandstone with twig impresions, 6 inches to	1	0
Clay with iron seams	6	0
Coal, 0 to	0	4
Fireclay or firesand, 1 to	4	0
New Livingston coal, sometimes part cannel slate, 8 inches to	2	0
Fireclay and shale with iron seams 0 to	4	2
Hard, fine-grained sandstone (ganister) with fossil plants 4 to	6	10
Shale and sandstone slate	6	4
Limonite (iron "boxes")	0	7
Covered interval, probably slate	6	10
Shale and slate, in some places replaced partly by laminated sandstone	21	10
Shale, rolled and with iron seams, partly covered, 0 to	10	8
Coal	1	6
?Fireclay	4	0
Massive to slaty sandstone, somewhat bituminous, lower 2 to 3 feet may be comglomeratic, 18 to	23	0
Slate, somewhat ferruginous, 0 to	5	0
Livingston coal.. Coal 9 inches to 1 foot; Fireclay, 1 foot 2 inches; Coal, 1 foot 1 inch — 1 foot 7 in. to.	3	3
Livingston conglomerate:		
Fireclay, impure, 0 to	4	0
Sandy slate with iron seams, 0 to	2	6
Slaty sandstone, 8 feet 3 inches to	10	8
Coal, including 4 inches bone coal, 0 to	1	6
Fireclay	1	3
Gray shale with iron seams with an occasional layer of sandstone 20 to	27	0
Covered interval to top of Leitchfield limestone	5	0

GENERAL SECTION AT, AND SOUTH OF PINEHILL.

	Ft.	In.
Pinehill formation)		
Covered interval to top of hill, with sandstone at base	..	..
Black slate, 10 to	12	0
Corley Hollow Coal.—Splint coal with "sulphur" bands up to one inch thick, usually most abundant near the top of the coal; sulphur-chalybeate water; 27 to 36 inches, average about	2	7
Fireclay, 0 to	8	0
Blue to black slate with 2 inches iron carbonate at base	6	2
Sandstone, partly slaty	5	0
Black slate with iron carbonate concretions	2	0
Siliceous carbonate ore	0	11
Slate, chiefly, but grading into laminated sandstone below	29	0
Laminated sandstone	15	0
Slate grading into fireclay below, about	6	0
Coal	0	2
Fireclay, plastic and light-colored, but iron-stained on outcrop	5	0
Ferruginous shale, partly covered, probably including much sandstone	24	10
Fireclay with sand-iron veins at least	8	0
Sandstone, hard and knotty, 8 to	1	3
Blue slate , 5 to	6	0
Dark to gray-white plastic fireclay, 3 feet 9 inches to	5	0
New Livingston coal, 8 to	0	12
Gray plastic fireclay (shale), 5 to	6	0
Darker shale, 0 to	1	9
Blue slate	2	6
Sandstone and covered interval with good fireclay at base, about	10	0
Fine-grained white micaceous sandstone, massive but grading downward into laminated, knotty sandstone	6	0
Micaceous sandy slate with ganister-shale at base	20	8
Shale with iron seams	6	0
Hard fine-grained sandstone	1	3
Sandy ferruginous shale with sand iron veins	4	8
Fireclay (shale) with sand iron veins	6	0
Coal, 10 inches to	1	4
Covered interval including some sandstone	12	0
Gray sandy micaceous, iron stained slate containing pyritious concretions and plant-impressions, about	5	0
Livingston coal: Splint coal, no "sulphur" 24 inches; Fireclay 8 to 24 inches; Coal, 6 to 8 inches	4	8
Livingston conglomerate:		
Covered interval	36	0
Ferruginous, calcitic limestone	4	0
Gray shale	1	0
Dark micaceous laminated sandstone, 7 to	10	0
Covered interval to Leitchfield limestone (3rd bed from base), 0 to	16	0

SECTION AT LIVINGSTON

	Ft.	In.
Pinehill formation:		
Covered interval to top of hill, with sandstone at base, 40 to	50	0
Black slate, no cannel slate	5	0
New Livingston coal, 19 inches to	2	8
Fireclay	3	6
Hard sandstone	2	0
Soft mottled sandstone, covered interval, and soft sandstone	22	10
Hard sandstone with fossil plants	1	4
Covered interval, 14 feet 6 inches to	22	1
Black slate, 5 to	6	0
Livingston coal: Coal, 24 inches; Fireclay, 6 to 8 inches; Coal, 24 inches	4	8
Livingston Conglomerate:—87 feet.		
Fireclay and covered	1	6
Hard sandstone	1	0
Covered interval	7	6
Coarse-grained sandstone	12	8
Coarse-grained sandstone to coarse conglomerate	5	0
Coarse conglomerate	1	6
Black slate with 2- to 3-inch layers of conglomerate sandstone and also of iron-lime carbonate, 7 to	14	0
Black slate with 16-inch sandstone at the top and with thinner layers below	6	0
Coarse-grained sandstone	8	8
Sandstone, partly covered, the lower 8 feet coarse-grained	28	5
Conglomerate sandstone to water of Roundstone creek	11	2

SECTION ON WHITE OAK ROAD.

	Ft.	In.
Covered to top of hill in road	20	0
Pinehill formation:		
Black slate; Covered interval; Sandstone, thin, with water below	60	0
Covered interval	7	0
Massive sandstone, cross-bedded to some extent, about	35	0
?**Corley Hollow coal,** position of; black slate	4	0
Ganister rock	3	0
Covered interval about	1	0
Sandstone	2	0
Shale; Black slate; Sandy shale	24	8
Coal	0	2
Fireclay; Shale	12	0
Ganister rock	0	8
Shale with slaty sandstone at the top	38	0
Slaty sandstone, some solid beds	20	0

SECTION ON WHITE OAK ROAD. (CONTINUED.)

	Ft.	In.
Black slate	22	4
Shale, partly covered Iron bed Black slate	27	2
Sandstone	0	2
Coal	0	2
Iron bed	0	6
?**New Livingston coal**	0	8
Fireclay, fair quality but slightly iron stained Shale with ferruginous nodules, seams, and iron boxes Micaceous sandy slate Black slate	1 20	0 4
Laminated sandstone with iron boxes at top Joints strike N. 60° W.	23	0
Covered interval	8	0
Purple shale and covered to	..	..
White Oak	20	0
Livingston coal	2	0
Livingston conglomerate:		
Black slate with iron concretions	..	..
Sandstone	..	..

SECTION AT GAULY HILL, ONE MILE WEST-NORTHWEST OF LIVINGSTON.

(No allowance for dip.)

	Ft.	In.
Pinehill formation:		
Covered interval to top of hill, about	40	0
Fine-grained cross-bedded and thick-bedded sandstone	35	0
Laminated and cross-bedded sandstone	23	6
Black slate	16	0
Sandstone shale about	5	0
Gray and black slate, sandy at the top (dip 8° south)	24	0
Ganister rock with iron concretions	2	0
Black slate	3	0
Iron concretions in sandy slate	1	0
Fireclay with iron seams	2	6
Gray slate	2	0
Coal	0	6
Gray shale (?fireclay)	2	0
Ganister rock	5	4
Shale	4	9
Coal		6
Drab and yellow shale	10	10
Sandstone containing iron "boxes"	0	6
Covered interval	12	6
Laminated sandstone	13	2
Shale with iron seams, partly covered	26	8
Coal	0	6
Fireclay	2	0
Ganister rock	0	6
Massive sandstone (same as with Stigmarial on Wildcat)	8	0
Slaty sandstone	3	0
Drab shale with iron seams above	10	0

(CONTINUED.)

	Ft.	In.
Coal, ?New Livingston, 1 to	2	6
Fireclay with iron seams Gray shale with iron seams	30	8
Covered interval	8	0
Covered interval to top of lower conglomerate of Livingston conglomerate	80	0

SECTION AT SAND RIDGE, 1½ MILES SOUTHWEST OF LIVINGSTON.

	Ft.	In.
Corbin conglomerate:—69 feet 6 inches.		
Covered to top of hill	8	0
Pink, soft sandstone with iron seams	10	8
Iron Ore	0	6
Pink, soft sandstone with iron seams	15	0
Covered interval	3	0
Iron conglomerate (pebbles cemented with good limonite and some sand	3	0
Pink soft sandstone	29	4
Pinehill formation:—267 feet 2 inches.		
Covered	1	8
Slaty sandstone, some iron, etc	6	10
Limonite	6	6
Thin bedded sandstone	7	0
Covered interval	3	6
Heavy sandstone with uneven top and with iron veins	2	6
Covered interval	18	8
Impure gray shale (fireclay) with iron seams	24	0
Sandstone	0	11
Slaty sandstone with sandstone lens at top	2	13
Fine-grained heavy bedded sandstone (used for culverts)	3	0
Gray monplastic shale with fine sandy slate at top	7	2
Fireclay with iron seams and covered	7	2
Siliceous (silty) fireclay shale	1	6
Covered interval, probably includes Corley Hollow coal	30	0
Fireclay shale, 2 in. black slate, sandy shale	7	6
Fireclay shale	3	0
Covered interval	7	4
Soft sandstone	2	0
Fine-grained white micaceous sandstone	24	0
Sandstone slate	10	6
Covered interval with 8 in. sandstone at top	76	2
Shale grading into slaty sandstone	2	6
Hard sandstone	0	6
Gray plastic shale and covered interval probably includes New Livingston coal	16	0
Covered interval	64	0
Livingston coal: Coal weathered, 1 foot 9 inches Fireclay, 2 inches rock, 1 foot 6 inches Coal, 3 feet	6	3
Livingston conglomerate:—28 feet 8 inches.		
Covered interval, probably plastic shale	2	0
Laminated fine-grained sandstone, hard and compact in upper part, shaly in lower part	20	4
Covered interval, shale at the top	6	4
Leitchfield limestone in branch.		

SECTION OF WILDCAT MOUNTAIN.

By Mr. C. J. Norwood with some Additions by F. J. Fohs.

	Ft.	In.
Covered to top of hill	20	0
Corbin Conglomerate:		
Conglomerate of small pebbles grading into coarse pink sandstones near base, about	105	0
Pinehill formation:		
Laminated sandstone, wave and ripple marked, thin seams of fireclay	20	0
Mostly concealed, but with some bluish, drab sandy shale and black slate at base	10	0
Massive sandstone	10	0
Black slate with coal near base	4	0
Slaty sandstone 2 to	3	0
Dark and drab argillaceous and argillaceous sandy shale	15	0
Covered interval	10	0
Dark drab shale	10	0
Sandstone with iron "boxes"	0	8
Argillaceous sandy shale, bluish and drab in color, 30 to	20	0
Sandy shale merging below into shaly sandstone	10	0
Massive sandstone	10	0
Sandy slate	3	0
Coal; also spring; coal at least	0	6
Sandy shale	12	0
Hard sandstone, three or more beds, the top being filled with *stigmariae*	10	0
Sandy slate	6	0
Coal	0	9
Shaly sandstone and sandy shale, about	12	0
New Livingston Coal	1	6
Hard sandstone filled with *stigmariae* rootlets	2	0
Drab clay	2	0
Coal	1	6
Drab and yellowish shale	5	0
Dark blue shale marging into blue and yellowish shale, with kidneys of iron ore	5	0
Covered interval	11	0
Sandstone disintegrated in certain parts, particularly toward base, ferruginous boxes occur in the upper and larger part	10	0
Covered interval, probably includes Livingston coal and Livingston conglomerate	47	10
Leitchfield formation:		
Marly, olive green shale	5	0
Limestone, 6 in. to	1	0
Calcareous, greenish drab shale	6	0
Limestone	1	6
Shale, 2 to	4	0
Limestone to ford	45	0

SECTION AT BILLOWS.

	Ft.	In.
Covered to top of ridge.		
Pinehill formation: (Lower section, inclusive of Livingston coal, absent).		
Massive sandstone about	18	0
Covered	75	0
Corley Hollow coal	4	0
Covered	35	0
Covered to top of road	29	0
Shale with water	..	..
Massive, partly slaty sandstone	13	6
Shale with iron "boxes"	16	8
Slaty sandstone with some iron layers	8	8
Ferruginous shale, partly covered	19	0
Covered interval	3	0
Slate and ferruginous shale	7	6
Black slate	0	2
Fire clay	0	8
Coal	0	1
Ferruginous sandy shale	23	4
Soft shale (fireclay) and covered	10	8
New Livingston coal	0	8
Shale and sandstone	7	6
Sandstone with *stigmariae*	2	6
Covered interval	7	6
Ferruginous sandy shale	16	0
Coal	0	2
Shale	0	9
Greenish sandy shale with layers of iron boxes and veins	12	0
Ochery ferruginous slaty sandstone	2	0
Top of Leitchfield shale	313	4

CHAPTER III.

STRUCTURE.

Since the strata of the county appears practically horizontal, it would seem that its structure is extremely simple, but a close study shows the contrary to be the case. The difficulties in arriving at the true structure are many and are due to three structural features: 1.—Irregularities in deposition; 2.—Unconformabilities; and 3.—Monoclinal folding with occasioanl minor folds and faults.

1. Irregularities in deposition:—These are the result of variation in the floor upon which the beds were laid down; the floor either being slightly inclined or else extremely irregular from erosive forces which left hills here and valleys there; and to thickening and thinning of the beds and formations. Thus the Sparks bed varies from 11 to 30 feet and the Mt. Vernon bed from 8 to 19 feet. The Ste. Genevieve limestone with a thickness of 77 feet at Big Hill thickens going southward until at Sinks it is 109 feet thick, and going westward it is about 150 feet thick at Mt. Vernon. The St. Louis limestone with a thickness of 58 feet at Big Hill is 56 feet thick at Mullins, and going westward it thickens to 100 feet, four miles west of Mt. Vernon. The Keokuk limestone with a thickness of 12½ feet at Big Hill has a thickness of 25 feet at Wildie and thickens to 35 feet at Little Renfroe to the west of Mt. Vernon. Thus it appears that the Mississippian limestone thickens going southward and still more going westward. The original inclination of the sea floor

upon which the limestones and likewise the earlier formations were laid down, is purely conjectural.

2. Unconformabilities:—These are of two types, unconformabilities of erosion and unconformabilities jointly of erosion and dip, the latter type marking the greatest break between eras of deposition, such a sharp break occurring at the top of the Mississippian limestones, and doubtfully a similar one occurs at the top of the Ohio shale. Unconformabilities of erosion occur above the Niagara, Ohio shale, Waverly, Keokuk, Orlando and Mullins formations and possibly a minor unconformability at the top of the Ste. Genevieve. The unconformability at the top of the Mississippian limestone shows erosion to have cut out its formations frequently as much as 75 feet when all of the Leitchfield shale is absent and from this to as much as 185 feet as at Mullins quarry where 35 feet of the Ste. Genevieve was removed, and 205 feet or more where over 55 feet of Ste. Genevieve has been removed as at Livingston. This maximum erosion appears along what was an ancient channel following pretty well the present general course of Roundstone creek, the channel being of varying but unknown width. Minor unconformabilities occur not only between the several limestone beds but also between the other beds, especially in the case of the conglomerates and sandstones of the Rockcastle series. In the case of an unconformability of erosion, the beds after deposition were elevated and exposed to land or fluvial erosive forces for a period of time prior to their depression and the depositions of the next succeeding beds. Where an unconformability of dip also is present, the beds were tilted prior to the deposition of the next succeeding beds, and this is what happened before the Rockcastle series of rocks were deposited.

3. Monoclinal folding with occasional minor folds and

faults:—There were clearly two periods of folding, one prior to and the other later than or partly during the deposition of the Rockcastle series. The Cincinnati geanticline, the main structural feature of Central Kentucky, reaches eastward so that the strata of Rockcastle county just border its flank, and the first monoclinal folding was incidental to this uplift and affects the central and western portions of the county. The second, affecting slightly the southeastern portion of the county, was possibly related to the folding attendent on the formation of the Cumberland mountains. With this second folding the Mississippian limestones were still further depressed in a southeasterly direction. In addition to these major foldings there were minor foldings with occasional minor faulting along the axis of such folds. These wave-like folds which locally raise and depress the strata gently are common to the flanks of the Cincinnati anticline. Having closely studied the limestones with a view of determining the extent of these folds, the following notes, the result of sections in a southeasterly direction are of interest. No cross-section is presented in the following form since a true diagramatic section would scarcely show within the limits of one possible to publish in this report. The irregularity in thickness of the bedding which was not always taken into account and the different horizons make the notes which follow, of varying value, but they are sufficient to show the general southeasterly dip, and the minor variations upon which comment has been made.

County line to two miles and a half east of Broadhead:

At the line there is an outcrop of 60 feet (full thickness here) of the Ohio shale.

Immediately west of Gum Sulphur is a small fault in the shale, the fault striking N. 85° W., with steep westerly

dips immediately west of the fault but with general southeasterly dip of the shale. A second fault occurs about one-half mile east of Gum Sulphur, which fault strikes N. 68° W., and is otherwise similar to the first. Here the shale shows capping of lower Waverly. The black shale shows jointing and minor folding. The general estimatd southeasterly dip (not allowing for the faults) between the county line and the top of the Waverly about two miles and a half southeast of Broadhead on the Mount Vernon road is 1 foot in 118 feet, nearly 1° of dip; estimate using top of Waverly as datum plane. Within the next mile, with Waverly the surface rock, the dip is only 1 foot in 630 feet. Some small veins filled with quartz, fibrous, transverse to the strike cut the Waverly shales. These strike N. 45° E.

Three miles southeast to Mt. Vernon:

The Mississippian limestones are here the surface rock and the base of the Ste. Genevieve, the flint conglomerate has been taken as the datum plane, no allowance being made for the thickening of the formations:

1. Dip S. E. 1 ft. in 156 ft. ..... 1200 yards
2. Dip S. E. 1 ft. in 183 ft. ..... 1375 yards
3. Dip N. W. 1 ft. in 15 ft. ..... 265 yards
   Probable fault striking about W. 45° E. on crest of anticline.
4. Dip S. E. 1 ft. in 176 ft. ..... 940 yards
   Probably fault of small displacement.
5. Not allowing for fault dip S. E. of 1 foot in 38 feet; 100 yards to railroad track at Mt. Vernon.

Mt. Vernon to Pinehill, using top of Tribune limestone as datum plane, in about 4.4 miles, the dip southeast is 1 foot in 128 feet if an allowance of 45 feet be made for thinning of the beds, the actual dip is 1 foot in 103 feet. The top of the Ste. Genevieve drops about 35 feet in two

miles along the Mt. Vernon-Burr road. The hill on this road is on a syncline of low curvature.

Between Pinehill and Sinks, reckoning with the top of the Tribune as a datum plane the dip southeast is 1 foot in 220 feet, and the dip due to tilting practically zero since the beds thin about 45 feet or the same as the beds drop in that distance. Between Pinehill and Livingston, the dip southeast is 1 foot in 148 feet (no allowance for thinning of beds). Between Pinehill and Sinks there are heavy local dips, the limestone in the first railroad cut from Sinks dipping 1 foot in 43 feet. Further toward Pinehill the conglomerate rests upon 6 to 20 feet of Tribune, most of the Tribune and all the Leitchfield having been eroded prior to its deposition. Beyond third crossing from sinks toward Pinehill, the sandstone rests directly upon upper Ste. Genevieve beds.

Between Big Hill onthe north border of the county and Livingston the dip figured on the top of the Ste. Genevieve (no allowance for thickening of beds southward) is 1 foot in 158 feet. Between Langford and Mullins based on the top of the Waverly, the dip is south 1 foot in 204 feet.

Between Mullins and one mile south of Sinks, the beds from the Orlando to the Leitchfield show at the level of the railroad track. Between Sinks and Mullins the beds rise about 105 feet or about 1 foot in each 45 feet. Upon the erosion-leveled beds thus tilted here, the conglomerate sandstone rests.

Between Sinks and Livingston, the dip south is 1 foot in 173 feet. Between Pinehill and Billows it may be estimated as 1 foot in 197 feet, based on the top of the Tribune as datum plane. Based on top of the Ste. Genevieve, the dip southeast between Brushy mountain and Livingston is 1 foot in 136 feet.

On the road from Mt. Vernon to Wildie, in the county road about one mile southwest of the railroad crossing south of Wildie, is a sheeted zone in the Mullins member of the St. Louis limestone. The zone is about 5 feet wide and is cemented with brown calcite. A similar zone occurs in a railroad cut between Burr and Pinehill, nearer the former place; this is 42 inches wide and strikes N. 5° E. Neither of these are of value.

CHAPTER IV.

ECONOMIC RESOURCES.

Clay and Shale.

The following are the clay and shale horizons which may become of interest:

Ohio black shale.—May become useful for portland cement and eventually for its hydrocarbons.

Waverly formation.—Sandy shales usually containing clay ironstone concretions; may be used chiefly for common brick. The basal bed of the Waverly is a calcareous clay shale suitable for common brick, terra cotta and tiling.

Keokuk limestone.—Just beneath the Atherton bed is a yellowish calcareous to greenish silicious shael from 4 to 10 feet thick.

St. Louis-Ste. Genevieve.—The residual clays will do for brick and Portland cement.

Leitchfield formation.—This contains the usually marl beds and as in the hill just south of Mt. Vernon, there is a considerable thickness of these. Where colored they are suitable for paints. They can probably be used to good advantage in connection with the pure limestones of the Ste. Genevieve for the making of Portland cement.

Rockcastle series.—This contains in the Pinehill formation, numerous beds of sandy to ferruginous argillaceous shale suitable chiefly for common brick and terra cotta. In the middle of the Livingston conglomerate there is also

at times developed a bed of dark shale. The most valuable clays in the county, however, are the fireclays of the Pinevill formation. These occur at and generally just below the three main coal beds but also to some extent associated with lesser coal seams in the intervals between the main coal beds. Sometimes these fireclays grade into firesand or ganister rock. The main fireclay horizon, however, is that of the New Livingston coal and is of considerable thickness in those areas where that coal is thin as at Pinehill and to the south and west of Pinehill for three or four miles, and also just east of Mt. Vernon. Some localities at which this clay has been prospected are the following: Lovell hill east of Mt. Vernon; J. S. McHargenes' entry; Pinehill; Col. August's prospect, one mile southeast of Pinehill; Mrs. Fannie Hansell land, four miles southeast of Mt. Vernon.

By referring to that part of the general section of the hill between Mt. Vernon and Burr, which shows the New Livingston coal, the character of the section obtained at Dr. Lovell's clay prospect will be seen.

The section at McHargue's entry immediately northeast of the Pinehill depot is as follows:

	Inches
Sandstone.	
Blue Slate	60 to 72
Dark to gray white plastic shale (good fireclay)	60
Coal	10 to 12
Gray plastic shale (good fireclay)	63
Dark gray shale	21
Blue slate	30
Sandstone and covered to Livingston coal, 65 feet.	

This entry is operated by the Lonsdale Face Brick Co., of Knoxville, Tenn. The entry is 200 yards north of the railroad.

Col. August's prospect shows the following section:

	Inches
Sandstone.	
Shale with iron sand veins	72
Hard sandstone	8 to 10
Fireclay, good light colored plastic,	72 to 45 to 60
Coal	8 to 10
Fireclay, gray plastic	60 to 72
Blue slate	30
Sandstone.	

This vein was worked for 100 to 200 yards back and shipments made therefrom to Louisville, Ky.

On the Mrs. Hansell place, the following section was obtained:

	Inches
	24
Black sandy slate, more than	2 to 3
Coal	12 to 15
Black slate	60 to 72
Fireclay	
Shaly sandstone.	

Above this main clay, is a heavy bed of ferruginous silicious shale suitable for tile. Two other openings were made on this land, but to the south of the road and about one mile distant from that just described. At one of these there is reported to have from 120 to 130 inches of the fireclay.

The extent of this clay is approximately:

A fireclay occurs above the Livingston coal, two miles north of Climax.

These fireclays are excellent for firebrick, front brick, pottery, etc., as well as for Portland cement. They have been sold on a small scale at 90 cents per ton f. o. b. cars.

The cost of production is said to be as follows: The clay is mined on contract for 42 cents and loaded on cars for 10 cents additional, the labor for the latter costing 10 to 12½ cents per hour.

The following are analyses of fireclays sent to the Survey by Col. J. A. August to determine their availability as Portland Cement clays. The analyses and remarks are by Dr. A. M. Peter, Chief Chemist of the Survey. It was unfortunately impossible for the present writer to definitely determine the localities from which these samples were derived; except that the Corley vein corresponds to what is described in this report as the Corley Hollow coal vein as seen up Corley Hollow:

"Three samples of shale and clay sent Feb. 13, 1903, by Mr. J. A. August, Pine Hill, Ky., to determine if they are suitable for use in the manufacture of Portland cement, analyzed March 16, 1903.

10937.—Labeled "No. 1. Slate from roof of lower mine or 'Klondyke'. Thickness 6 to 8 feet; area over 2000 acres." A dark gray, compact shale.

10938.—Labeled "No. 2. Clay parting from between the two veins of seam of coal in same mine, 'Klondyke'. Thickness 6 to 14 inches; area over 2000 acres." A gray, soapy clay—looks like fire clay.

10939.—Labeled "No. 3. Clay from floor of 'Possum' vein. Thickness 4 to 10 feet; area over 1500 acres." A brownish, rather gritty clay.

"Five samples of clay sent by J. A. August, Pine Hill, Ky., for analysis to determine if they are suitable for the manufacture of Portland cement; analyzed June 20, 1903.

11357.—Labeled "No. 1, from floor of Corley vein. Thickness 6 to 8 feet; area 630 acres." A gray, sandy-looking clay with some scales of mica and a good deal of iron stain.

11358.—Labeled "No. 2, from floor of sulphur mountain vein; thickness 7 to 10 feet, area 500 acres." A gray, rather pure-looking clay, but with some iron stain. Looks like fireclay.

11359.—Labeled "No. 3, from hill in Nigger Hollow. Thickness 7 ft., area 800 acres." A stony, brownish-gray rather sandy-looking material.

11360.—Labeled "No. 4, from south side of North Mountain. Thickness 5 to 7 feet; area 300 acres." Similar to No. 3.

11361.—Labeled "No. 5, from Taylor Bottom. Thickness 1 to 15 ft., area 150 acres." A gray, plastic clay.

"Six samples of clay sent by J. A. August, Pine Hill, Ky., July 13, 1903, to determine whether they are suitable for making Portland cement. The samples were all of the same general character, being plastic clays containing varying amounts of ochreous material. Samples about ½ lb. each, received July 14; analyzed Sept. 24, 1903.

11608.—Labled "No. 36, from Midle Mountain, about 175 feet elevation. Depth of bed, 7 to 10 feet; extent, 250 acres." Nearly white clay, but some places ochreous and iron-stained.

11609.—Labeled "No. 37, from Middle Mountain, about 175 feet elevation. Depth of bed 8 ft., extent, 250 acres." Similar to No. 36 but of darker buff color, the ochreous material being more uniformly distributed.

11610.—Labeled "No. 38, from Middle Mountain, about 25 feet elevation. Depth about 6 to 8 feet; extent, 300 acres." A yellow clay.

11611.—Labeled "No. 39, from Middle Mountain, about 300 feet elevation. Depth of bed 5 feet; extent, 150 acres." Similar to No. 36 and No. 37, but less iron-stained.

11612.—Labeled "No. 40, from Middle Mountain, south end of old tram. Depth of bed 7 to 9 feet; extent, 150 acres." Nearly white; less ochreous than No. 36.

11613.—Labeled "No. 41, from Sulphur Spring Mountain near lead mine. Depth of bed 6 feet; extent, 150 acres. Very much like No. 36."

ANALYSES OF THE AIR-DRIED SAMPLES.

Sample Number	1 Slate. 10937	2 Clay 10938	3 Clay 10939	1 11357	2 11358	3 11359	4 11360	5 11361
Laboratory Number								
Moisture at 100° C.	1.02%	2.59%	2.36%	1.33%	3.07%	1.19%	1.92%	6.10%
Ignition	6.86%	5.97%	9.04%	6.43%	5.73%	5.64%	5.92%	6.45%
Silica	70.03%	65.70%	58.22%	71.10%	64.45%	71.17%	66.18%	57.79%
Alumina	13.61%	21.89%	27.12%	18.14%	20.54%	18.06%	19.91%	19.43%
Peroxide of iron	6.24%	2.22%	3.71%	1.64%	2.88%	1.59%	3.82%	5.29%
Lime	0.38%	0.24%	0.20%	0.19%	0.13%	0.06%	0.16%	1.04%
Magnesia	0.25%	0.23%	0.22%	trace	0.21%	0.44%	0.66%	1.51%
Potash	0.71%	1.10%	0.89%	0.39%	0.60%	0.26%	0.38%	0.51%
Soda	trace	0.14%	0.29%	0.21%	0.26%	0.21%	0.15%	0.15%
Sulphuric acid	0.05%	trace	trace	trace	trace	trace	trace	trace
Total	99.10%	100.08%	102.01%	99.43%	97.87%	98.62%	99.10%	98.27%

Sample Number	36	37	38	39	40	41
Laboratory Number	11608	11609	11610	11611	11612	11613
Moisture at 100° C.	2.09%	2.13%	3.72%	2.30%	2.11%	2.54%
Ignotion	7.55%	7.02%	7.58%	8.21%	7.18%	7.29%
Silica	60.14%	60.68%	55.68%	55.32%	60.26%	56.06%
Alumina	27.00%	24.29%	19.91%	30.52%	24.12%	28.13%
Peroxide of iron	2.86%	1.71%	9.43%	1.28%	3.42%	3.57%
Lime	0.15%	0.15%	0.30%	0.30%	0.30%	0.25%
Magnesia	0.20%	0.40%	0.92%	0.36%	0.44%	0.36%
Sulphurie anyhydride	trace	trace	trace	trace	0.65%	trace
Total	99.99%	96.38%	97.54%	98.29%	98.48%	98.20%

"Nos. 10938 and 10939 have the right composition for raw materials to be used with limestone in the manufacture of Portland cement. No. 10937 contains too much silica in proportion to its alumina for use alone, but it might possibly be used in admixture with a clay rich in alumina, such as No. 10939.

"Of the next five clays, No. 5 is best suited for use in the Portland cement industry. The others are fire clays of fair quality. Nos. 1 and 3, especially, would make quite refractory, siliceous fire brick.

"The remainder are all suitable for the manufacture of Portland cement and most of them would be very desirable for that purpose. No. 11610 is, perhaps, the least desirable, on account of its large per cent. of iron. Some of the other samples are very fair fire clays, especially No. 11611."

COAL.

The conglomerate series which constitute the Rockcastle group includes at least nine coal seams but only three of these are fairly persistent and are usually but not always thick enough to work. These three coals called in this report beginning with the lowest, respectively, the Livingston, New Livingston, and Corley Hollow beds occur in a vertical range of 250 feet of strata in the Pinehill formation. The intervals between these coals together with their relation to the Leitchfield formation is briefly restated below after which is given a description of each of the beds and of the prospects opened on each:

ROCKCASTLE GROUP 450 FEET THICK.

	Feet	Average Feet
Corbin conglomerate; pink sandstone and pea conglomerate...	45–105	12
Unconformability of erosion.		
Pinehill formation:—330 feet thick.		
Shale with thin sandstones, a heavy sandstone and slate...	40–115	91
Corley Hollow coal, 30 to 55 inches.		
Alternating beds of argillaceous shale and sandstone including a thin coal, and with cannel slate or fireclay at the base	131–158	144
New Livingston coal, 8 to 36 inches.		
Plastic fire clay, ganister rock, slate, laminated sand and a thin coal, with slate at base	58–87	77
Livingston coal including shale parting 32 to 72 inches.		
Livingston conglomerate; two sandstone members separated by a shale member and including a thin coal	22–89	42
Unconformability of erosion		
Leitchfield formation:		
Extent of exhaustion.		

Livingston Coal.—The characteristics of this coal are shown in the following generalized section:

Sandstone.	Inches
Gray to black sandy, micaceous, slightly ferruginous shale containing pyritious niggerheads, 0 to 72 inches	60
Hard splint coal usually free from "sulphur", 9 to 36 inches, averge	20
Gray to black fireclay or shale, 6 to 54 inches, usually less than, but averages	21
Coal, usually soft, rarely cannel, 6 to 36 inches	16
Fireclay, 18 to 42 inches	24

The position of the Livingston coal (named after Livingston, Rockcastle county, where old openings occur shortly above the level of the railroad tracks) varies greatly in its relationship to the underlying limestones due to the irregularities in erosion of the limestones. Where a deep channel was eroded as at Livingston, this coal bed occurs more than 87 feet above the limestone, the ancient channel having eroded away completely in this instance the Leitchfield formation, Tribune limestone and part of the Ste. Genevieve. In other instances as at Billows where the Leitchfield formation remains rather fully developed the Livingston coal is absent; in this instance, there was a hill which had not been base-leveled to the level at which this coal was deposited. It is entirely improbable that in Rockcastle county, at least, that this coal splits up into several thin coals as has been suggested by some, but instead where deposited it appears to show the characteristics previously described; furthermore, it maintains a fairly definite relationship to the New Livingston coal, that is, if present the Livingston coal occurs at an average depth of 77 feet below it.

It has been worked out chiefly in the immediate vicinity of Livingston, but elsewhere only to a small extent.

There remains of this coal at least 000 square miles with an average net coal thickness of 36 inches with an average parting of 21 inches. The best method of working this coal is to remove the parting by a post machine, then shoot either the top or bottom coal accordingly as one or the other may be the thicker, after which the thinner bed may be removed by wedging or picking.

New Livingston Coal.—The following is the general section of this coal horizon:

	Inches
Drab shale.	1
Black slate, 60 to 120, but usually	60
Plastic fireclay or occasionally firesand, present only when coal below is thin, 20 to	60
Cannel slate usually with more or less pyrite in layers and in seams, present when fireclay is absent; seen only in the region between Mt. Vernon and Hansford, O., to	25
New Livingston coal, good splint with a little "sulphur", upper part rarely cannel; a thin parting in one instance; south of Mt. Vernon and in vicinity of Livingston from 19 to 36 inches thick, but between Mt. Vernon and Pinehill and south of the latter place it is from 8 to 18 inches thick, average	24
Plastic fireclay, 32 to 72 inches at Pinehill and to the south and west, elsewhere, 0 to	24
Firesand (ganister rock) with *Stigmarae*, 0 to 72, average	48

This coal is named after the mines where it has been most developed across Roundstone creek from Livingston. This horizon is fairly persistent at an average elevation of 77 feet above the horizon of the Livingston coal, but shows coal of workable thickness only locally but the fireclay present where the coal is thin compensates in a manner, so as to make the bed valuable for coal or fireclay nearly everywhere in the county. Thus it may occur at a height 50 to 150 feet above the erosion surface of the Mississippian rocks.

The probable extent of this coal in Rockcastle county is about 000 square miles.

It has been worked out locally in the vicinity of Livingston, and a small acreage in the Mt. Vernon-Hansford region. However, but a very small part of the original acreage of this coal in the county has yet been worked.

There remains of this coal at least 000 square miles with an average net thickness of 24 inches. The best method of working this coal will be the removal of the underclay which usually will have a value itself, and then shooting or wedging the coal down.

Corley Hollow Coal.—The following is the general section of the Corley Hollow coal:

Sandstone.	Inches
Black slate, 0 to 30 feet, average	60
Corley Hollow Coal, hard splint coal, sometimes softer near top, contains a little "sulphur", and may have a few inches of draw slate; in the Pinehill-Livingston region, 30 to 32 inches thick, and in the Brush creek-Billows region 54 to 85 inches, hence usually 30 to	55
Shale, fireclay, or ganister rock, 9 to 96 inches, average	60
Sandy clayey shale.	

This coal has been named from the hollow at the head of which it has been most extensively worked about one mile southeast of Pinehill. This coal has been worked chiefly between Pinehill and Livingston and on the waters of Brush creek. The original acreage, coming as it does near the tops of the hills, was small and while only a small acreage has been mined the total net acreage remaining is about 0000, which with a average of 36 inches of coal would yield a net recoverable tonnage amounting to 0000 tons. This is an excellent coal and where present can be worked to good advantage. The best method will be by shearing and removing draw slate and soft coal at top prior to shooting.

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COAL PROSPECTS.

The following notes give details of the coals of Rockcastle county, so far as they have been examined:

KENTUCKY RIVER DRAINAGE.

Little Nigger Creek of Dix River.

Brushy Mountain entry.—New Livingston coal; the coal is 18 to 20 inches thick and occurs 85 feet above the Leitchfield limestone.

Blue Lick Branch of Red Lick Creek of Station Camp Creek.

Charley Abraham entry.—New Livingston coal; this is at the top of Big hill, at the junction of Madison, Jackson, and Rockcastle counties, one-fourth mile east of the road. The coal is 42 inches thick inclusive of 3 inches of bone coal. Under a thin fireclay there is 40 feet of sandstone. This coal is about 100 feet above the Ste. Genevieve limestone. This bed is doubtfully grouped with the New Livingston bed.

ROCKCASTLE RIVER OF CUMBERLAND RIVER DRAINAGE.

Line Creek of Rockcastle River.

Joseph Bullock prospect.—Livingston coal; reported by Mr. Miller as 30 feet above the Leitchfield shale; the coal is 27 inches thick and probably the Livingston bed. This is about two miles and a fourth northwest of Pong, and at the head of Line creek on the south side of Kinkaid ridge.

W. T. Evans prospect.—This is on the Kinkaid ridge also but further west. Mr. Miller reports 14 inches of coal, 60 feet above the limestone; this coal may be the Livingston bed.

Buffalo Creek of Rockcastle River.

J. L. Cooper entries.—Corley Hollow Coal. One of these is one one-half mile east of the road near Billows. This is 216 feet above the top of the Leitchfield shale, and 290 feet above the Leitchfield limestone. The section of this coal is as follows:

	Inches
Shale which drops in mining in large masses.	
Hard splint coal with pyrite partings at 16 and 32 inches from the top	48
Hard black slate.	

The other entry is 225 feet above the Leitchfield limestone and is one-fourth mile west of the road near Billows. The section here is as follows:

	Inches
Slate some of which peels off readily.	
Coal with little sulphur	55½
Black slate more than	12
Interval of about 15 feet then heavy sandstone ledge.	

French Branch of Rockcastle River.

Buck French entry.—Livingston coal. This is about one mile south of Walton's. The coal is 36 inches thick inclusive of six inches of black clay parting. This coal is 35 feet above the Livingston conglomerate limestone. Immediately below the coal is gray slate and the usual stream of water. The roof is very slate also.

Walton Branch of Rockcastle River.

John Walton entry.—Livingston coal. This is one mile and a half southwest of Livingston. The coal is 30 feet above the Leitchfield limestone and the section is as follows:

Gray sandy micaceous slate.	Inches
Splint coal	36
Shale	48
Cannel coal	15
Sandstone.	

Rockcastle River.

Henry Owen entry.—Livingston coal. This is on the Livingston-Mt. Vernon road, one-fourth mile southwest of the former place. The section here is as follows and the coal is 29 feet above the top of the Leitchfield limestone in the branch below:

	Inches
Coal (weathered on outcrop)	21
Fireclay	16
Sandstone	2
Coal	36
Shale, covered	24
Laminated sandstone.	

Roundstone Creek.

New Livingston entries.—New Livingston coal; extensive work has been done in these. They were well equipped with electric haulage, tram across river, etc., but were unsuccessful financially. The coal is about 140 feet above the Rockcastle river and 120 feet above the lower conglomerate member of the Livingston conglomerate. The section is as follows:

Sandstone.	Inches
Black slate, 48 to 72 inches	60
Coal, 32 to 40 inches	36
Fireclay, 36 to	48

Moberly branch of Roundstone Creek.

Old Livingston entries.—Livingston coal. These are on the south side of the branch, one mile northeast of Livingston, where 15 to 20 acres have been mined. The section here is as follows:

Sam R. Sams entry.—New Livingston coal. This is located two miles east of Sinks. The coal occurs ten feet above the top level of a heavy bed of conglomerate. The section of the coal bed is as follows:

Black slate.	Inches
Semi-birdseye cannel contains some pyrite	18
Coal contains some pyrite	18
Fireclay exposed	24

Gauly Hill entry.—This is one mile east-northeast of Livingston and on the north side of the road. It shows 12 to 30 inches of coal capped with iron-seamed drab shale and underlaid with iron-seamed fireclay.

Roundstone Creek.

Sambrooks entries.—Livingston coal. These are immediately northwest of Livingston on the south of the Pinehill road. This coal, going northwest is 45 feet above the Leitchfield limestone while to the southeast at Livingston it is 87 feet above the Ste. Genevieve limestone. The section obtained at one of the entries was as follows:

Black slate.	Inches
Coal	24
Fireclay, 6 to	8
Coal	24
Fireclay and covered space	18
Hard sandstones	12

Sambrooks entries.—New Livingston coal. These are immediately northwest of Livingston and on the south of

Pinehill road. This coal is from 49 to 58 feet above the Livingston coal and presents the following section:

Sandstone.	Inches
Black slate	60
Coal, 19 to 32 inches	24
Fireclay, silicious	42
Sandstone.	

Grisham entry.—Livingston coal. An outcrop along this road one-half mile further northwest showed the following section:

Sandstone slate.	Inches
Coal	12
Clay	21
Coal	24
Shale, 36 to	48
Laminated sandstone..	

Near this point, also south of the road was the Guisham entry.

East Fork of Skaggs Creek of Rockcastle River.

Hansell entry.—Livingston coal. One mile southeast of the Hansell entry on Piney branch on the East fork waters there is by the side of the road another Hansell entry. The coal occurs 30 feet above the Leitchfield limestone and shows the following section:

	Inches
Coal	12
Clay, 6 to	12
Coal	12

Wade Graves entry.—New Livingston coal. The following section was obtained at this point; between this and the Price prospect the dip is 40 feet east-southeast per mile:

Sandstone (probably twig rock).	Inches
Slate, 6 to	8
Cannel slate, contains minute seams and one-inch bands of pyrite	25
Coal, contains some "sulphur"	21
Fireclay	6
Sandstone with *stigmariae*.	

This is one mile and a half northeast of Hansford. and is said to be 85 feet above the Leitchfield limestone.

Sinking Creek of Skaggs Creek.

Nichols land (formerly Joel Woodall's)—New Livingston coal. The twig rock between the house and spring probably occurs five feet above the New Livingston coal, which would be about 90 feet above the Livingston conglomerate limestone.

Ralph Heirs prospect.—New Livingston coal. This is one mile east of the Nicely prospect on the same coal. (Miller).

Skaggs Creek.

George Pittman entry.—New Livingston coal. A coal probably of this horizon has been opened here but it was not possible to measure the coal. A cannel coal is reported opened on the same land at a lower horizon, while 175 feet higher under a sandstone 25 feet thick, is the probable position of the Corley Hollow coal. This is on the Skaggs creek drainage on the south of the creek, one mile northwest of Pongo.

Dry Fork of Skaggs Creek.

M. J. Nicely prospect.—New Livingston coal. This is one-half mile east-northeast of Hansford. Mr. Miller reports this as 80 feet above the limestone (Leitchfield),

and the coal 36 inches thick under six to eight inches of cannel slate.

G. H. Price entry.—New Livingston coal. This is one mile west of the Graves prospect, and 77 feet above the Leitchfield limestone. The section here is as follows:

	Inches
Black slate.	
Cannel slate, 2 to	8
Coal, 30 to	33
Firesand rock containing *stigmariae*, grading into harder sandstone below	24

John Marley entry.—This is three-fourths of a mile south-southwest of the Cummins entry, next described. According to Mr. Miller there are eight inches of cannel slate above 20 inches of coal.

Buck Cummins prospect.—Livingston coal. Fifteen feet above the Leitchfield limestone there is 4 to 24 inches of splint coal probably belonging to this bed. This five miles south of Mt. Vernon and one-fourth mile east of the Hansford road.

Buck Cummins entry.—New Livingston coal. The following is the section at this entry, which is 90 feet above the Leitchfield limestone:

	Inches
Black slate.	
Cannel slate contains pyrite seams	15
Coal, splint; dip irregular; 27 to	28
Underclay	6
Cavernous sandstone, 15 feet.	

This entry is five miles south of Mt. Vernon and one-fourth mile east of the Hansford road. About one acre has been mined in the 16 acres in the tract.

Piney Branch of Roundstone Creek.

Sinks entry.—New Livingston coal. One-half mile west of Sinks, a coal has been opened according to Mr.

Miller which is 24-25 inches thick and 110 feet above the Tribune limestone.

McHargue prospect.—Livingston coal. Mr. John S. McHargue reports a coal as follows on his land just north of Pinehill.

	Inches
Coal, 22 to	24
Clay, 8 to	24
Coal, 8 to	10

This coal is 42 feet above the top of the Leitchfield limestone.

Corley Hollow entries.—Corley Hollow coal. These are one mile south of Pinehill, and occur near the head of the hollow. The coal has been worked rather extensively at this point so that a number of acres are exhausted; how many could not be learned. This coal bed occurs 198 feet above the Livingston coal and 270 feet above the Leitchfield limestone; the section is as follows:

	Inches
Black slate, 120 to	144
Splint coal with pyrite bands up to one inch thick, usually heaviest near the top of the bed; heavy sulphur-chalybeate stream	32
Fireclay, from 0 to 96 inches	48
Blue slate.	

Josiah Struthers entry.—This is one mile and a half south-southwest of Pinehill. The section is as follows:

	Inches
Black slate.	
Splint coal, softer toward top, contains only a little pyrite, 27 to 36 inches	30
Fireclay, 6 to	8
Sandstone	8
Fireclay.	

Steel Price entry.—Livingston coal. This is about half way between the two Hansell entries but on the north side of the ridge. Here the coal is said to be 30 inches

thick. A coal occurs above a sandstone at a higher horizon in his orchard, and another at a lower horizon which is below a thin sandstone and above a slaty sandstone. This was formerly the John Overby land, and the 30-inch vein has been practically exhausted on it.

Jeff Lovell entry.—Livingston coal. Here the coal is said to run about 24 inches reaching a maximum of 36 inches, and has been practically exhausted. It is about 40 feet above the Leitchfield limestone.

Hansell entry.—Livingston coal. Two entries were examined on the land of Mrs. Fannie Hansell on this bed. One of these is on the north of the road near her house on the waters of Piney branch, two miles southeast of Mt. Vernon where the section was as follows:

	Inches
Sandstone.	
Coal, 6 to	8
Clay, 12 to	18
Coal, 2 to	3
Sandstone.	

Roundstone Creek.

Welsh's entry.—This according to Mr. Sullivan is 180 feet above the limestone and shows the following section:

	Inches
Coal	12
Shale	18
Shaly sandstone	18
Coal	24
Clay.	

This is near Mullins and under the third heavy sandstone; it is provisionally correlated with the Corley Hollow coal.

Crooked Creek of Roundstone Creek.

Albert Allen entry.—Livingston coal. This probably belongs to this horizon. According to Mr. Miller the coal is 30 inches thick and occurs 45 feet above the Msisissippian (presumably Leitchfield) limestone.

W. D. McGuire entry.—This is also on Crooked creek, where Mr. Sullivan measured the following section, 75 feet above the limestone.

	Inches
Shale.	
Coal	28
Shale	1½
Coal	7
Clay.	

John Solomon entry.—New Livingtson coal. This entry according to Mr. Miller is on the west of the ridge between Crooked creek and Barnetts valley, and the coal is 38 inches thick, 65 feet feet above the Leitchfield shale.

L. J. Scott entry.—Corley Hollow coal. This is on Crooked creek waters on the opposite side of the ridge from the Big Hill Coal Co. entry. According to Mr. Miller this is the same bed as at the Big Hill openings, but is only 110 feet above the Newman limestone, and is 48 inches thick.

Due north one mile and a half from Orlando between Brush and Roundstone creeks, Mr. Miller describes other openings which he groups with that last described.

Roundstone Creek.

Mt. Vernon-Pleasant Valley road entry.—Livingston coal. The coal here is 19 to 36 inches thick, and is 40 feet above the Leitchfield limestone. The entry is caved.

Brush Creek of Roundstone Creek.

Dave Clark's entry.—New Livingston coal. This is near Orlando and is said to show 30 inches of coal. Its position was not determined.

Brush Creek entry.—Livingston coal. This according to Mr. G. M. Sullivan is one mile above Orlando and the coal which shows the following section is 60 feet above the limestone:

	Inches
Bituminous shale..	
Bone coal	2
Coal	25.5
Clay	
Sandstone conglomerate.	

This coal is provisionally correlated with the Livingston bed.

Tarlton Clark entry.—Livingston coal. This also was reported by Mr. Sullivan as on Brush Creek, 85 feet above the limestone, and showing the following section:

	Inches
Shale.	
Boney Coal	2
Coal	50
Bituminous shale.	

Big Hill Coal Co. entry.—Corley Hollow coal. This is an entry begun in 1910, on the waters of Brush creek. The entry was started south with the dip of the coal. Where measured the coal was 54 inches thick, but where previously developed, it is said to have reached a thicknes of 85 inches. The section in this vicinity is roughly as follows:

	Inches
Sandstone, 35 to	51
Coal, 8 to	26
Slaty sandstone	5
Slate	35
Corley Hollow coal, 54 to	85
Slaty micaceous sandstone	30
Coal, 6 to	12
Interval with 25 feet of sandstone at base	145
Interval to top of Leitchfield limestone	165
Orlando limestone	30
Waverly to tram road track, about	55

Brush Creek.

One mile north of Climax.—Livingston coal. This is on the road to Big Hill. The coal is 30 feet above the Livingston conglomerate limestone and about 65 feet above the Leitchfield formation. The section is as follows:

	Inches
Slaty sandstone 21 feet 4 inches. (Blackish, perhaps bituminous).	
Black slate	24
Shale	53
Coal	10
Fireclay	53
Coal	12
Slaty sandstone.	

Town Branch of Renfroe Creek of Roundstone Creek.

Dr. Lovell entry.—Livingston coal. This is on the Mt. Vernon-Buhr road one-half mile from the former place. The section here is as follows:

	Inches
Conglomerate sandstone, slightly bituminous, 24 to	36
Slate, 0 to	60
Coal, 9 to	12
Fireclay	14
Coal	13
Plastic fireclay, 0 to	48
Slaty sandstone.	

Elsewhere in this hill, this coal bed, which has been rather extensively worked (perhaps half exhausted), varied from 19 to 36 inches. It is from 28 to 42 feet above the Leitchfield limestone and is the second coal, there being a thin coal below it.

Hill on Mt. Vernon-Buhr Road.—New Livingston coal. This coal is too thin or split by partings and does not have sufficient good fireclay to be valuable for the latter although the ganister rock may eventually prove of value (see New Livingston coal in section of this hill in Chapter II).

Rockcastle River.

Widow Griffith (Spiery) entry.—This according to Mr. Sullivan is two miles above Livingston, and 75 feet above the limestone. The outcrop section which he reported is as follows:

	Inches.
Shale.	
Coal	33
Clay.	

Trace Branch of Rockcastle River.

Wm. Bummets entry.—One-half mile east of Gauly hill entry, this shows a coal 18 inches thick.

Jack Sams entry.—This is on Trace branch, in the bed of the creek, one-half mile from the mouth. The coal is said to be 28 to 35 inches, usually 30 inches thick. The roof is black slate, and the floor gray shale.

White Oak Creek of Rockcastle River.

J. R. Mullins entry.—Livingston coal. A coal 24 inches thick was opened up a west hollow on the White Oak road near White Oak. Another is exposed at a spring

100 yards west of Mullin's house; this coal is 8 inches thick and beneath a slaty sandstone. Below the coal is underclay. Whether this forms part of the Livingston bed could be determined by digging through the underclay to see whether there is a lower bench of coal.

?Hiram Jennings prospect.—Livingston coal. About one mile below the Mullins prospect on the White Oak road the Livingston coal outcrops with the following section:

	Inches
Coal	12
Clay	13
Coal	16

COAL ANALYSES.

No. 1220.—Coal from Henry Mullin's bank; in a ridge which divides Roundstone from Skagg's creek waters; one mile southwest of his house, and five miles southeast of Mount Vernon. Bed, 40 inches thick, with a capping of three feet of very hard, bluish slaty shale, and above it six inches of blue shale. Similar to 1219.

No. 1219.—Coal from Wm. Dyer's bank; ?New Livingston coal; on McClure branch of West fork of Skagg's creek, about 8 miles east of south from Mt. Vernon. Bed only stripped; 3 feet disclosed but is about 40 inches thick with about 3 feet of black slate roof. Collected by Joseph Leslie, Jr. Rather a dull looking coal, pretty tough; not much fibrous coal between the layers. Exterior stained with ochreous oxide of iron.

No. 1947.—Coal from Myzners and Myers' bank; Livingston. An interconglomerate coal. Average sample by A. R. Crandall; taken 150 yards in, entry No. 1. Average thickness of bed 28 inches. A pure looking, glossy-black

splint coal. But little fibrous coal between the laminae, and no apparent pyrites. ?Livingston coal.

No. 1948.—Coal from the same mine. Entry No. 2. Average sample collected by A. R. Crandall. Much like preceding in appearance. ?Livingston coal.

No. 1949.—Coal from Grisham's coal mine, near Livingston. First above the conglomerate. Upper "brashy" coal bed. Average thickness 2 feet. Average sample by C. J. Norwood. A splint coal. Fibrous coal and much granular pyrites between its thin laminae.

No. 1940.—Coal, from same mine. From the lower nine inches of the two-foot bed. Local name "block coals". By C. J. Norwood. A deep, black glossy coal, irridescent in parts. But little fibrous coal or pyrites apparent.

No. 3016.—Coal; from Coffee branch of Crooked creek. Average sample of 36-inch bed. Collected by G. M. Sullivan, May 31, 1889.

No. 3017.—Coal; "Spicy coal" from near Livingston. Bed 84 feet above Mississippian limestone. Average sample from the face of the whole 33-inch bed. Collected by G. M. Sullivan, July 17, 1889. (Probably New Livingston coal.)

No. 3018.—Coal; on Tarlton Clark's land, known as Clark's bank, Brush creek, 4½ miles from Brush Creek station. Bed 85 feet above the Mississippian limestone. Average sample collected by G. M. Sullivan, from the 52 inch face, August 6, 1889. (Probably New Livingston coal.)

COMPOSITION OF ROCKCASTLE COALS.

Laboratory	No. 1220	No. 1219	No. 1947	No. 1948	No. 1949	No. 1950	No. 3016	No. 3017	No. 3018
Hygroscopic moisture	1.70%	1.66%	2.00%	2.20%	2.20%	2.10%	3.80%	4.20%	4.40%
Volatile combustible matters	36.30%	37.74%	35.66%	36.50%	35.86%	39.50%	31.00%	33.70%	31.00%
Coke	62.00%	60.60%	61.34%	61.30%	61.94%	58.40%	65.20%	62.10%	64.60%
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Total volatile matters	38.00%	39.40%	38.66%	38.70%	38.06%	41.60%	34.80%	37.90%	35.40%
Carbon in the coke	59.80%	58.26%	51.94%	51.70%	54.94%	49.86%	56.20%	55.90%	60.20%
Ash	2.20%	2.34%	9.40%	9.60%	7.00%	8.54%	9.00%	6.20%	4.40%
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Specific gravity	12.59%	1.249%	1.318%	1.357%	1.327%	1.374%	.....	.....	.....
Character of coke	Moderat dense spongy	Spongy	Light spongy	Light spongy	Spongy	Spongy	Dense	Dense friable	Spongy
Color of ash	.....	.....	Lilac-gray	Dark lilac-gray	Light chocolate	Purplish gray	Very light gray	Light brownish gray	Light gray
Percentage of sulphur	0.685%	1.818%	2.205%	4.802%	4.302%	2.933%	0.412%	0.968%	0.494%
Comp. of Ash of	No. 1220								
Silica	0.784%								
Al_2O_3, FeO, Fe_2O_3, MgO	.580%								
Carbonate of lime	.084%								
Magnesia	.366%								
Sulphuric acid	.111%								
Potash	.046%								
Soda	.343%								
	2.314%								

FREESTONE.

Two horizons occur in the Waverly group in Kentucky at which fine-grained argillaceous sandstone suitable for building stone and commonly called freestone occurs; one of these constitutes the Buena Vista beds near the base of the Cuyahoga formation and is quarried in Rowan and Lewis counties, while the other is that of the Upper Waverlyan, here called the Hummel bed which is quarried in Rockcastle county and occurs about 300 feet higher than the Buena Vista beds which are not a commercial horizon in Rockcastle county.

The Hummel bed occurs from 5 to 15 feet below the top of the Waverly, and consists of a single bed of freestone 6 to 9 feet thick. Above and below are freestone beds from 5 to 24 inches thick usually slaty and interbedded with more or less shale. Some of these where under sufficient cover, may prove of value but in the operating quarries only the 6 to 9-foot bed is used.

Two quarries are worked at the present time, one by The Freestone Co., at Hummel and another by the Kentucky Rockcastle Stone Co., at Wildie. At the former, the quarries have been operated at least 25 years, and the workable bed reached a maximum thickness of nine feet though where now worked it is six feet thick. At the Wildie quarry it is 7½ feet thick, and has a thin row of nodules 18 inches below the top.

The stripping is from 18 inches to 25 feet thick, but when the bed is at its maximum it will permit the removal of 35 feet of stripping. The stripping except for the upper 10 or 12 feet of dirt, is chiefly freestone, although there is 2 to 6 feet of Keokuk limestone below the dirt. The stripping is usually done between November 1st and March 1st.

The quarrying details are as follows: Holes are drilled 15 to 16 feet deep, 20 feet back from the face and 40 feet apart, and the bottoms of the holes are sprung with powder after which they are charged with as much as 75 kegs of powder to break the stripping for the full length of the quarry. After the stripping is removed the main block is quarried by drilling holes 18 inches to two feet apart, 5½ feet deep. The blocks are afterward split in two parts. Reamers of one inch square steel are used with bits 2⅛ to 2½ inches by ⅜ inch. A gill of powder is used per hole on top of which a wad of straw is placed to within 15 to 18 inches of the top after which the hole is tamped with dirt or crushed stone to the top. Ingersoll steam rock drills are used fitted with bull bits. One-half gallon of powder supplies 25 holes.

The cost of quarrying is about 3½ cents per cubic foot and labor costs 10 cents.

Blocks are marketed containing as much as 125 cubic feet. The actual weight per cubic foot is about 165 lbs. The blue rock sells at 50 to 72 cents, the olive and buff at 35 cents, sawed per cubic foot in Cincinnati. The rough stone sells at about 25 cents per cubic foot. The stone is usually laid on its natural bed and is sawed with that intent.

The average value of the stone f. o. b. the quarries is about as follows:

Rough stone.....25 cents per cubic foot.
Sawed stone.....55 cents per cubic foot.

The wages paid are as follows:—Quarrymen, sawyers, yardmen, engineer and blacksmith, each $1.50; muckers, $1.30 to $1.50; and foremen, $2.00 to $2.50 per 10 hours.

The Wildie plant has a 60 h. p. boiler and 40 h. p. engine operating two saw gangs. The Hummel plant has

a 70 h. p. boiler and a 50 h. p. engine and four saw gauges. At both plants are hoists for handling and moving stone, usually of 20 h. p. and have vertical boiler attached which consume about one bushel of coal per hour. The coal consumption at one plant was reported as about 15 tons per 1000 cubic feet of stone quarried, only one-fourth of which was sawed.

LIMESTONE.

General Character.

One of the richest resources of the county is its limestone of which there is a thickness of upwards of 300 feet. The Mississippian limestone constitutes in its various formations the bulk of this, although at the base of the Devonian in northeastern Rockcastle county is 10 to 20 feet of stone which is valuable for certain purposes, but which covers only a small outcrop area. The Mississippian limestone area is pierced by the two branches of the Louisville and Nashville Railroad which makes a considerable part of it immediately available to transportation. A railroad up Skaggs creek which will probably come in the future will make available a further considerable area of this resource. Already the limestone forms one of the principal industries of the county and it is believd that when it becomes known what the great possibilities in this line are here, it will be greatly extended.

The following table presents briefly the general character of the beds, giving also the list of analyses representative of them:

LIMESTONES OF ROCKCASTLE COUNTY.

Mississippian Limestone.		Thickness.	Physical Character.	List of Analyses.
Leitchfield..... 55 feet	Upper limestone.....	22 ft.	Coarse crystalline, dark.....	3291
	Middle member.....	11 ft.	Shale and crystalline limestone.....	
	Lower limestone.....	22 ft.	Crystalline, some semi-oolitic.....	3290
Tribune..... 25–31 ftt	Crinoid stem bed.....	20–25 ft.	Semioolitic crystalline.....	3266; 3289
	Middle bed.....	0 to 1 ft. 9 in.	Fine granular crystalline.....	3269
	Pentremite bed.....	3 to 4 ft.	Coarse crystalline.....	3265; 3270
Ste. Genevieve. 91–130 feet	Upper member.....	8 to 22 ft. 9 in.	Brecciated compact, fine crystalline, and laminated beds.....	3271, 3272, 3273, 3274, 3292, 3276
	Sparks bed.....	11 to 30 ft.	White oolitic, some compact layers..	3263, 3277, 3278, 3280
	Middle member.....	6 to 15 ft. 8 in.	Compact and flinty beds.....	3279
	Mt. Vernon bed.....	7 to 19 ft. 6 in.	White oolitic with yellowish oolitic in part.....	3282, 3283, 3275, 3288
	Lower member.....	45 to 74 ft.	Dark oolitic; some compact and flinty beds.....	3260, 3261, 3268, 3284, 3285, 3287, 3286, 3267, 3256
St. Louis..... 70–106 feet	Mullins member.....	22 to 49 ft. 8 in.	Compact, crystalline and flinty beds.	3257, 3258, 3259, 3281
	Orlando member.....	45 to 57 ft.	Compact earthy.....	3264, 3390
Keokuk..... 12–35 feet	Atherton bed.....	5 ft.	Coarse silicious to calcareous conglomerate.....	
	Harrodsburg limestone	12 ft. 6 in. to 35 ft.	Compact earthy.....	3262
	Geode bed.....		Compact earthy with geodes.....	
Waverly.....No limestone.				
Devonian—Corniferous limestone at base			Coarse crystalline and compact.	

Limestones of Rockcastle County.

The remarkable purity of certain of the beds is worthy of special mention:

The Tribune offers from 23 feet 8 inches to 28 feet 10 inches of limestone running from 90.38 to 91.22 per cent. available carbonates (allowance having been made for fluxing the contained silica and alumina. The Ste. Genevieve limestone offers two beds, the Mt. Vernon and Sparks. The former bed offers locally the purest limestone in considerable thickness, showing at Mt. Vernon 17 feet 10 inches containing the unusually high per centage of 97.55 per cent. available carbonates; this bed thins one-half mile east of Mt. Vernon at the Sparks-Davis quarry to 7 feet 1 inch, and two miles west of Mt. Vernon at the Sparks quarry, it is eight feet thick but only the upper four feet are pure enough, the lower four feet being magnesian limestone; in the vicinity of Sinks it thins to 5 feet and appears less pure. The Sparks bed offers usually 10 to 12 feet averaging 94.92 per cent available carbonates. It is also lenticular but on the whole more regular in thickness, as well as quality, when compared with the Mt. Vernon bed, showing its greatest thickness likewise at Mt. Vernon where there are 27 feet 10 inches of pure limestone; it usually carries one to three thin partings of magnesian limestone additionally, which, however, could be easily culled.

It will be seen from the analyses that these Rockcastle limestones are as good as any to be found. These limestones are available under sufficient area close to the railroad to be quarried profitably. Farm land such as carries these formations can, except at Mt. Vernon be purchased for from $5 to $30 per acre. The rock can be quarried, including impure beds (which can be sold for ballast, etc.),

for about 45 cents per long ton. The best stone selected for special uses would probably sell crushed at between 60 to 75 cents per long ton, f. o. b. cars.

QUARRY SECTIONS.

The following are brief notes on present and prospective quarries of the county, which can supply limestone suitable for varied purposes. For details of the sections at the Sparks and Davis, Kinger, Sparks and Big Fill, reference may be made to the generalized Mt. Vernon section. The laboratory numbers of analyses begin in each instance with the topmost beds:

Sparks and Davis quarry. (W. J. Sparks. Co.)—This is located about one half mile east of Mt. Vernon on the Louisville-Norton division of the L. & N. R. R. The section in this quarry is as follows:

	Ft.	In.
Dirt stripping, 3 to	5	0
Tribune white oolite	10	0
Ste. Genevieve limestone:		
Upper limestone	4	10
Sparks bed	11	6
Middle limestone	21	5
Mt. Vernon bed	7	1

Kruger quarry. (Mt. Vernon Lime Co.)—This is located immediately south of the depot at Mt. Vernon. The section in the quarry together with that above the quarry on the hillside shows 70 feet of pure limestones, the greatest thickness of such limestones in the county:

	Ft.	In.
Birdsville limestone:		
Third limestone (3291)	30	0
Middle limestone	100	6
First limestone (3290)	22	0
Tribune limestone	26	4
Ste. Genevieve limestone:		
Upper limestone	14	0
Sparks bed, pure limestone excepting 2 feet 8 inches	30	6
Kruger... Middle limestone	17	0
quarry. Mt. Vernon bed, (3288)	17	10

Sparks quarry. (W. J. Sparks Co.)—This is located two miles northeast of Mt. Vernon, and shows the following section:

	Ft.	In
Birdsville limestone to the top of the quarry	12	6
Tribune limestone, pure limestone excepting 2 feet 5 inches (3289, 3269, 3270)	31	1
Ste. Geneveive limestone:		
Upper limestone (3271, 3272, 3273, 3274, 3292, 3276.)	18	3
Sparks bed pure limestone except 1 foot	12	11
Middle limestone (3279)	6	3
Mt. Vernon bed (3282, 3283, 3275)....6 to	8	0
Lower limestone to bottom of quarry, (3284, 3285, 3287, 3286)	26	0

On the Town branch road one mile north of Mt. Vernon there is exposed some 80 feet of the dark oolitic limestone of the lower Ste. Genevieve.

On the railroad between Mt. Vernon and Maretburg is about 100 feet of the Ste. Genevieve limestone. Further west the lower limestones can be had.

Big Fill prospect.—The following section was obtained in the railroad cut immediately east of the Big Fill about 1½ miles east of Mt. Vernon:

	Ft.	In.
Sparks bed	8	0
Compact brecciated less pure limestone....1 to	6	0
Mt. Vernon bed-pure limestone except 0 to 10 in. less pure limestone 6 feet 4 inches to	11	4

On the railroad between Mt. Vernon and Pinehill and between Pinehill and Sinks are many good exposures chiefly of Ste. Genevieve limestone and higher limestones, while at Pinehill is the following section:

	Ft.	In.
Leitchfield limestone.		
Limestone, ferruginous, 27 to	30	0
Shale, water horizon	6	0
Limestone and shale	40	0
Tribune limestone.		

The sections previously described are on the Louisville-Norton branch of the Louisville and Nashville Railroad. There follows descriptions of points on the Cincinnati-Knoxville division of the same railroad. For a section of the limestones in northeastern Rockcastle county, reference may be made to the Big Hill section previously given.

Wildie prospect.—The Tribune limestone outcrops on a hill about one mile north of Wildie on the eas of the railroad between one-fourth and three-eighths of a mile, which is the point nearest Cincinnati (140 miles), where a quarry could be opened in these pure limestones. Where measured, the Tribune limestone, one mile south of Wildie, was 48 feet thick (no allowance made for dip) so that there should be a considerable thickness of the Tribune in that vicinity. The full section of limestone to the top of the Waverly occurs between this and the valley below, the general section in the vicinity of Wildie being approximately as follows (no allowance made for dip):

	Ft.	In.
Tribune limestone	48	9
Shale	2	0
Ste. Genevieve (allowing for dip of 2°):		
Upper member, compact and semi-crystalline limestone, about	18	0
Sparks bed, middle member and Mt. Vernon bed, chiefly covered, about	30	0
Lower member, dark oolitic limestone inclusive of 1 foot of compact limestone (3256)	62	0
St. Louis limestone:		
Mullins member, compact flinty and crystalline limestone, about (3257)	25	0
Orlando member, chiefly compact	45	0
Clayey limestone.		
Keokuk:		
Clayey limestone, geode bed and shale	25	0

Orlando prospect.—Immediately at Orlando in the hills on either side a complete section of Mississippian limestone occurs. North of the second tunnel north of Orlando is a section from the shale in the Orlando member well up into the Ste. Genevieve. In the railroad cut 21½ feet of clayey compact limestone of the Orlando member of the St. Louis limestone were sampled for analysis (No. 3300).

Between Orlando and Dudley the same limestones continue.

Dudley quarry.—This quarry is located 21 feet above the base of the Ste. Genevieve and works dark oolitic limestone (No. 3268) 22 feet thick. Further back higher on the hill a quarry could well be located on the Sparks bed. The full section here is as follows:

	Ft.	In.
Rockcastle series.		
Ste. Genevieve limestone	110	0
St. Louis limestone:		
Mullins memebr: Compact and crystalline limestone	12	0
Orlando member: finely crystalline and clayey compact limestone	65	o
Keokuk limestone.		
Waverly sandstone.		

Mullins quarry.—The following is the section at this quarry:

	Ft.	In.
Livingston conglomerate sandstone	50	0
Unconformity with upper 35 feet of Ste. Genevieve limestone, inclusive of Sparks bed at base, missing.		
Ste. Genevieve limestone:		
Middle member, Mt. Vernon bed, compact limestone including 1 foot of fossiliferous	9	0
Lower member.		
Compact limestone, some beds contain occasional chert nodule.	27	0
Gray oolitic, partly cross-bedded more or less silicious limestone	26	0
Impure crystalline limestone	13	0
St. Louis limestone:		
Mullins member:		
Finely crystalline to compact and semilithographic beds, some beds flinty	21	11
Orlando member.		
Clayey compact limestone	5	0

There follows descriptions of three favorable prospects for quarries in the vicinity of Sinks. For the detailed section at these points reference may be made to the Sinks-Mullins section previously given:

Sinks prospect No. 1.—Thus is immediately south of the county road where it crosses the Cincinnati-Knoxville division of the L. & N. R. R. north of the railroad tower at Sinks. Here the Sparks bed carrying 9 feet 8 inches of pure oolitic limestone was sampled (No. 3263). It is covered by 6 to 8 feet of less pure limestone. While there is not sufficient acreage where sampled no doubt this could be obtained immediately back of the tunnel or just north of the county road just back from and higher up than the rock exposed in the railroad cut which shows this bed just removed by erosion.

Sinks prospect No. 2.—This is in the first railroad cut east of the tunnel at Sinks and east of the road crossing on the Louisville-Norton division of the L. & N. R. R.

Here there is 10 feet 2 inches of the Sparks bed, including only two small partings aggregating 1½ feet of less pure limestone. The covering is 23½ feet of less pure limestone.

Sinks prospect No. 3.—This is juct opposite the railroad tower at Sinks and between that and the conglomerate quarry one half mile south. Here there is a section of the Tribune limestone 26 feet 8 inches thick, suitable for many purposes though not quite as pure (Nos. 3266 and 3265) as some of the limestone from the Sparks and Mt. Vernon beds.

Foot of Wildcat quarry.—This is the quarry from which much stone was secured for use for bridge piers and ballast for the L. & N. Railroad which passes it. The limestone represents 45 feet of the Leitchfield formation and much of it is coarsely crystalline and an excellent stone for construction purposes.

Three-fourths of a mile northwest of Livingston, Tribune limestone outcrops upon which a quarry could be opened for local use, or a spur run thereto vary handily.

QUARRY METHODS, PLANTS, COSTS.

In breaking the stone, usually a single row of vertical holes is drilled at a distance of 10, 12, or 15 feet back from the face, but in one instance two rows are drilled with alternating holes at a distance of 4 and 8 feet respectively from the face. The depth of holes varies from 6 to 17½ feet, though usually it is 9, 12, or 15, or 16 feet, depending on the grouping of the beds to be broken. The holes are placed either 5 or 8 feet apart. Rarely horizontal holes are of service. The holes are loaded with from 15 to 25

lbs. of dynamite each, and at only one quarry are they sprung before loading, this by 4 sticks of dynamite. At one quarry they figure to use 7⅔ lbs. ($1.00 worth) of dynamite per car (32 yards) of stone broken. No. 3 and No. 4 air rock drills of the Ingersoll-Rand, Jeffrey and McKinnon makes are in use. At the Dudley quarry, the drilling is done by hand. The rock is loaded by hand, usually into two wheel mule carts usually driven by half as many men or boys, (in one instance into wooden cars holding 2¼ yards each drawn by hoist); the carts hold about one-third cubic yard each and from 7 to 8 are in use at each quarry except the Dudley and Kruger. It is usually dumped directly into the crusher. A small gasoline engine and boiler and engine are used at the Sparks and Davis quarry for yard use, pumping chiefly. A boom derrick is in use at the Sparks quarry for moving large blocks of stone, etc.

The product is usually fed to a Gates gyratory crusher (Nos. 5, 6, and 7½ are used) and are raised by means of a chain elevator varying from 24 to 60 feet long, with from 12 to 20 cups, to a trommel screen of punched iron making two or more sizes, either with 3- and ¾-inch or with 3-, 1½-, and ½-inch perforations making ballast, concrete and screenings in the last instance, ballast and screenings only in the first instance. The oversize goes back for recrushing. At the Sparks and Davis plant, two crushers and two belts are used; the first crushing only to pass 3-inch ring, the second (a No. 4) to finish. The use of one crusher is ample except for very large plants. If two are used they should be so set as to feed from one to the other with the use of but one belt elevator for hoisting the finished product. From the finishing screen, the product feeds directly into the storage bins having two or three compartments according to products made, and of

course these vary according to size of plant. They are sufficiently elevated to feed directly into the railroad cars, for which purpose they are usually supplied with feed gates and short movable feed troughs of sheet iron. The bottom of the bins are usually sloped at a 45 degree angle. These bins vary in size and height, the largest set of three measuring 14 x 28 feet and 40 feet high, 16 feet deep in front and 8 feet deep in back and holding six cars. Power is supplied by 150 horse power boilers and 90 horse power engines at the large and 80 horsepower boiler and 50 horse power engine at the small plants. Four-inch run-of-mine coal costing $1.30 per ton is used for fuel.

The cost of labor per 10 hour day at quarry and plant is as follows: Foreman, $1.66⅔ to $2.00; timekeeper, $1.66⅔; drillers, $1.50 to $1.75; helpers, shovelers, and stone breakers, $1.00 to $1.35; sledgers, $1.50; engineers, $1.65 to $2.00; crusher feeders, $1.50; car levelers, $1.50; mule and driver, $2.50; driver alone, $1.25. At the five quarries 130 men are employed working about nine months each year.

The cost of quarrying and crushing in Rockcastle county varies between 35 and 50 cents per yard crushed stone (practically equivalent to a long ton of 2240 lbs.) During a favorable month with an output of 6000 yards at one of the most profitable quarries and crushing plants, the cost per yard produced was 41.5 cents (includes crushing which cost .066), but no allowance was made for interest on capital invested or for stripping, which would increase the cost about .027 making a total cost of 44.2 cents per yard. I am told the lowest quarrying cost is 30 cents per yard. The average crushing cost is about 7 cents per yard. The cost of a plant to quarry and crush 250 yards per 10-hour day would be about $6,000.

The price received per yard for limestone for various

purposes f. o. b. cars in Rockcastle county is as follows: Limestone screenings 25 to 50 cents; ballast rock 50 to 55 cents; and concrete rock 60 to 65 cents. Select crushed rock would probably sell for about the same price as the concrete rock, or perhaps a few cents higher.

The freight on crushed rock in car load lots is said to be 40 cents for the first 60 miles and 2 cents for each additional mile. This question however, hast bed be taken up direct with the L. & N. R. R. The distances from Cincinnati are: Mt. Vernon, 159.3 miles; Sinks, 151.5 miles; and Wildie 141.6 miles.

LIST OF OPERATORS.

The following are the operating quarries:

Kruger quarry, Mt. Vernon Lime Co., Mt. Vernon; small quarry for lime.

Mullins quarry, W. J. Sparks Co., Mullins, 1896; Ballast rock.

Dudley quarry, Winchester Granite Brick Co., Dudley 190; small quarry for lime.

Sparks quarry, W. J. Sparks Co., Burr, 1898; lime, ballast and concrete.

Sparks and Davis quarry, W. J. Sparks Co., Mt. Vernon, 1908; ballast and concrete.

LIME-KILNS.

There were three kilns, the Dudley, Kruger, and Sparks which produced about 5000 tons of lime in 1910 in the county.

The abundance of good limestones for lime burning especially for high-calcium lime, makes it desirable that

this industry shall be extended as far as possible. Heretofore there has been little magnesian lime produced but there are several beds which are suitable for this purpose (see table of uses under Limes.) A hydrating plant is also very desirable.

The rock for lime burning is usually hand-sorted and broken, nothing being put in the kiln larger than 10 inches or smaller than 3 inches, 6-inch cubes being the best size to use. After breaking to this size it is loaded into cars or wheel-barrows and loaded into the top of the kiln.

The Dudley and Kruger kilns are of sheet-iron, lined with fire-brick, and the Sparks kiln of limestone lined with firebrick. The first two kilns have a capacity of 75 bbls. and the Sparks kiln, 100 bbls. per 24 hours. Aside from the man employed to load the lime into the kiln, two men are required to fire the kiln, and one to draw lime and load barrels.

A description of the Dudley kiln and its practice is given which gives a good idea of the others:

The kiln shaft is 18 feet high and 6 feet in diameter inside of the brick. It is a steel shell lined with a single course each of sand-lime brick and firebrick. The pedestal is 6 feet high and built of sand lime brick which stand the heat splendidly, the firebox only being firebrick lined. The pedestal contains the fire chamber with two doors on the two opposite sides of the kiln, while lower on a third side are the two doors for drawing the lime. There is a drawing room built of sand lime brick attached, 30 feet long, 18 feet wide and 8 feet high and 10 feet to apex of the roof.

The limestone is charged at 6:30 A. M. and at 5 P. M. The day man draws 4½ feet of lime at 3:30 P. M. and the night man draws about 6 feet at the same time in the morning. The kiln with natural draft is fired continuously

on both sides; Straight Creek nut coal costing $2.30 per ton being used. The average draw per 24 hours is 75 bbls. or 7½ tons.

The lime usually sells at $3.00, rarely as low as $2.80 per ton in bulk at the kiln; the freight rate to Paris Ky., being $1.20; to Lexington, $1.30; to Cincinnati, $1.40. Barrelling costs extra $2.75 to $3.00 per ton (the barrel stock costs 17 to 20 cents, making 5 cents, loading 2 cents per barrel).

The cost of production is given at from $2.00 to $2.50 per ton. The cost for fuel seems to be the chief item and judging from statements given by the operators this varies widely according to the fuel used, the cost per ton of lime produced being as follows: Cord-wood, $1.07, charcoal, 97c, Straight Creek coal 47c. Wood and charcoal produce the best quality of lime but with a properly built kiln with artificial draft, the coal will produce a good and economical lime. The wood cost $2.00 per cord, charcoal $1.75 per cord, and coal $2.35 per ton. The remainder of the cost of lime per ton includes quarrying and stone about 60c, labor for loading, burning, and drawing, and the usual fixed charges such as superintendence, repairs, and interest on investment.

SUITABLE USES FOR ROCKCASTLE LIMESTONES.

The present uses of the limestone produced in the county are the following: Crushed rock for ballast, concrete, and screenings; and lump rock for lime used in mortar, tanneries, agriculture, and sand-lime brick. The output of limestone in 1910 was about 115,000 cubic yards. With the large area and thickness of available limestones in the county there is every reason why this output should be vastly increased, and this may best be done by extending

the uses to which it is put and is suitable; such uses are the following: Building stone, crushed stone, glass manufacture, open-hearth flux, calcium and magnesian caustic hydrated lime, Portland cement, sugar refining, agricultural limestone, and chemical processes. It is adapted for many of the other purposes also, which, however, are confined to industries either distant or impractical to establish here. The purposes for which there are no limestone to be had in the county are those requiring high magnesian content (as for furnace linings and other fire-proofing) and lithographic stone. Some lithographic stone occurs in the Mullins member of the St. Louis but it is too flawed to be of value.

With a view of developing this industry as fully as possible, at the suggestion of the Director, the writer has collected, and there has been analyzed by Mr. J. S. McHargue, the Survey chemist, limestones representative of the various beds of the Mississippian section. There follows, therefore, first a table giving these analyses and descriptions of the rock analyzed, followed by a table giving the specifications of limestone for the various uses to which it is put, followed in each instance by numbers of the analyses which showed beds suitable for the given purpose; the numbers are also used to represent those beds which display physical characteristics which bring them under Class I of the uses.

ANALYSES OF ROCKCASTLE LIMESTONES.

By J. S. McHargue and A. M. Peter.

No. 3256. "Fossiliferous compact crystalline limestone with semi-lithographic beds in upper part containing *Syringopora*. Immediately above main Lithostrotion bed. Thickness 5 feet 8 inches. St. Louis limestone. One mile south of Wildie on road to the east of the railroad. Rockcastle county, Ky. Collected by F. J. Fohs, August 4, 1910."

Average sample of medium size lumps of dark gray limestone having a slight conchoidal fracture. Some pieces of lighter color than others.—J. S. M.

No. 3257. "Dark oolitic limestone, inclusive of one foot of compact limestone. Thickness 63 feet. Lower member, Ste Genevieve. One mile and one-fourth south of Wildie on road east of the railroad. Rockcastle county. Collected by F. J. Fohs, August 4, 1910."

Average sample of medium size lumps of light gray and somewhat oolitic limestone containing some crystals of calcite and some brown particles which had the appearance of iron oxide. A very pure looking specimen.—J. S. M.

No. 3258. "Compact to semi-compact limestone, upper part brecciated. Thickness 8 feet 6 inches. Top par of Mullins member, St. Louis limestone. From exposure in railroad cut, one-fourth mile south of Mullins, Rockcastle county. Collected by F. J. Fohs, August 5, 1910."

Average sample of medium size lumps of dark gray limestone having an irregular fracture. A rather hard stone.—J. S. M.

No. 3259. "Crystalline, semi-oolitic, fossiliferous limestone. Thickness 4 feet, (some places 5 feet). Lowest beds of Mullins member. St. Louis limestone. South 150

yards from depot at Mullins, Rockcastle county. Collected by F. J. Fohs, August 5, 1910."

Average sample of medium size lumps of light gray crystalline limestone having a slight vitreous appearance. Some crystals of calcite observed. Some pieces exhibited weathering.—J. S. M.

No. 3260. "Dark fine-grained oolitic limestone, lower 4 feet 6 inches cross-bedded. Thickness 20 feet. Upper part of lower member, Ste. Genevieve limestone. In cut west of railroad, just north of county road crossing at Sinks Rockcastle county Collected by F. J. Fohs, August 5, 1910."

Average sample of medium size lumps of dark gray oolitic limestone. Some pieces show more oolites than others.—J. S. M.

No. 3261. "Dark oolitic, silicious-looking limestone, more or less cross-bedded with some pink flint and a 6-inch chert band in lower part, large *Spirifer* at base. Lower part of lower member, Ste. Genevieve limestone. One-half mile south of Mullins, Rockcastle county. Collected by F. J. Fohs, Aug. 5, 1910."

Average sample of medium size lumps of dark gray oolitic limestone. Some of the lumps were lighter in color than others.—J. S. M.

No. 3262. "Compact clayey limestone. Thickness 12 feet 6 inches. Keokuk limestone. Big Hill, Madison county, near Jackson and Rockcastle corner. Collected by F. J. Fohs, August 13, 1910."

Average sample of medium size lumps of brown stones. Look to be clayey and sandy. An impure looking stone.

No. 3263. "White oolitic limestone. Thickness 9 feet 8 inches. Sparks bed, Ste. Genevieve limestone. From exposure in railroad cut, immediately south of the county road crossing at Sinks, Rockcastle county. Collected by F. J. Fohs, August 5, 1910."

Average sample of medium size lumps of light gray limestone, somewhat vitreous in appearance.—J. S. M.

No. 3264. "Compact clayey limestone including one semi-lithographic bed, and some sandy and shaly layers; basal 7 feet has green markings. Thickness 32 feet. All except upper ten feet of Orlando member, St. Louis limestone. Big Hill, Madison county, a corner of Jackson and Rockcastle counties. Collected by F. J. Fohs, August 13, 1910."

Average sample of medium size lumps of gray crystalline with a few lumps of yellowish stone which appeared to have been altered by weathering. The lumps contained cavities of calcite.—J. S. M.

No. 3265. "Gray crystalline limestone. Thickness 3 feet 2 inches. Pentremite bed, Tribune limestone. Opposite railroad tower at Sinks, Rockcastle county. Collected by F. J. Fohs, August 5, 1910."

Average sample of dark gray crystalline limestone Medium sized lumps.—J. S. M.

No. 3266. "Crystalline oolitic limestone containing large crinoid stems which silicify on weathering. Thickness 20 feet, 6 inches. Crinoid stem bed upper member Tribune limestone. From outcrop west of railroad, one-fourth mile south of Sinks, Rockcastle county. Collected by F. J. Fohs, August 5, 1910."

Average sample of dark gray limestone having a slight conchoidal fracture, crystalline in character. No oolites seen as stated by collector.—J. S. M.

No. 3267. "Fine-laminated gray oolitic limestone. Thickness 8 feet. Basal beds of lower Ste. Genevieve member, resting immediately above St. Louis pink flint conglomerate. Big Hill, Madison County, near corner of

Jackson and Rockcastle counties. Collected by F. J. Fohs, August 13, 1910."

Average sample of medium size lumps of light gray oolitic limestone. Irregular fracture. Pure looking stone. —J. S. M.

No. 3268. "Dark silicious oolitic limestone, cross-bedded. Thickness 21 feet 10 inches. Lower Ste. Genevieve member, beginning at 21 feet above its base. Beds in Dudley quarry, Rockcastle county. Collected by F. J. Fohs, August 6, 1910."

Average sample of medium size lumps of dark oolitic limestone, somewhat vitreous in appearance.—J. S. M.

No. 3269. "Fine-grained crystalline limestone, with thin green sand layers between the beds. Thickness 1 foot 9 inches. Middle member, Tribune limestone. Sparks quarry, two miles northeast of Mt. Vernon, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of rather small size lumps of gray limestone streaked in places with iron, a rather hard and silicious stone.

No. 3270. "Gray coarsely crystalline limestone, basal layers somewhat compact, the whole containing *Pentremites pyriformis*. Thickness 4 feet. Pentremite bed, Tribune limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of dark gray medium sized lumps of hard flinty limestone having a conchoidal fracture.—J. S. M.

No. 3271. "Brecciated compact dark gray limestone cemented with green clay; weathers yellowish and the clay seams reddish-brown. Thickness 4 feet 6 inches. No. 29 of Mt. Vernon section. Top-most bed, upper member Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of medium size lumps of dark gray, light gray, and brown limestone, containing fossils. An impure looking stone. The brown stone had the appearance of chert, but effervesced with hydrochloric acid.—J. S. M.

No. 3272. "Granular compact laminated limestone. Thickness 2 feet 6 inches. No. 27 of Mt. Vernon section; upper member, Ste. Genevieve limestone. Collected by F. J. Fohs, August 9, 1910."

Average sample of medium and small size lumps of dark gray limestone having streaks of green in places, a rather fine-grained stone.—J. S. M.

No. 3273. "Compact limestone; thickness 3 feet 6 inches. No. 26 of Mt. Vernon section. Upper member, Ste. Geneveieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs. August 9, 1910."

Average sample of light gray limestone having a flinty appearance and a conchoidal fracture.—J. S. M.

No. 3274. "Gray coarsely crystalline limestone; thickness 1 foot 10 inches. No. 25 of Mt. Vernon section. Upper member, Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of light gray limestone; a very pure looking stone.—J. S. M.

No. 3275. "Dark oolitic, partly compact limestone; thickness 8 inches. No. 9 of Mt. Vernon section. Lower member, Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of dark oolitic limestone; a very impure-looking stone.

No. 3276. "Gray compact, probably magnesian limestone with calcite facets; thickness 3 feet 4 inches. No. 23 of Mt. Vernon section. Basal bed, upper member, Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of white-looking stone; a rather soft limestone.—J. S. M.

No. 3277. "Gray oolitic limestone; thickness 2 feet 6 inches. No. 20 of Mt. Vernon section. Top bed of Sparks bed, Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of white-looking oolitic limestone; a very pure-looking stone.—J. S. M.

No. 3278. "Dark compact crystalline limestone, grades into bed below; thickness 1 foot. No. 19 of Mt. Vernon section. Middle layer of Sparks bed, Ste. Genevieve limestone. Collected by F. J. Fohs, August 9, 1910."

Sample consisted of a few medium-size lumps of rather fine-grained crystalline limestone.—J. S. M.

No. 3279. "Semi-lithographic limestone, brecciated and with intercalated thin flint bands in upper part; thickness 5 feet 6 inches. No. 15 of Mt. Vernon section. Middle member, Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of medium size lumps of yellowish-gray flinty limestone having a conchoidal fracture.—J. S. M.

No. 3280. "White oolitic limestone; thickness 9 feet 5 inches. Contains 14 stylolitic planes. No. 18 of Mt. Vernon section. Lower part of Sparks bed, Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of medium sized lumps of light gray oolite; a very pure-looking stone.—J. S. M.

No. 3281. "Blue compact limestone containing silicified *Lithostrotion proliferum* and flint; thickness 7 feet 6 inches. Main Lithostrotion beds, St. Louis limestone. Big Hill, Madison county, near corner of Rockcastle and

Jackson counties. Collected by F. J. Fohs, August 13, 1910."

Average sample of dark gray limestone containing fossils replaced by silica; the fossils are of a beautiful pink color.—J. S. M.

No. 3282.—"White oolitic limestone; lower 2 feet 6 inches of upper 4 feet of Mt. Vernon bed, Ste. Genevieve limestone. No. 10b of Mt. Vernon section. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

White oolitic limestone very much like the Bedford; contains a few crystals of calcite. A very pure looking stone.—J. S. M.

No. 3283. "Buff oolitic limestone; thickness 4 feet. No. 10a of Mt. Vernon section. Lower half of Mt. Vernon bed, Ste. Genevieve limestone. Collected by F. J. Fohs, August 9, 1910."

Average sample of yellow-looking oolitic limestone, having a sandy feel, rather friable.—J. S. M.

No. 3284. Dark compact, brecciated limestone; thickness 3 feet 6 inches. No. 8 of Mt. Vernon section. Near top of lower member, Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of dark colored limestone; a rather hard flint-like stone.—J. S. M.

No. 3285. "Dark oolitic limestone containing occasional flint nodules; horizontal bedding; thickness 5 feet 6 inches. No. 6 of Mt. Vernon section. Lower member Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of dark gray oolitic limestone; a very nice specimen of stone except for dark color.—J. S. M.

No. 3286. "Dark gray oolitic, somewhat silicious lime-

stone containing sandy-clay patches, and including 2½ inches of flint-limestone conglomerate, 5 feet 5 inches above the base; thickness, 9 feet 2 inches. Horizontal bedding. Nos. 2 and 3 of Mt. Vernon section. Lower member, Ste. Genevieve limestone. Collected by F. J. Fohs, August 9, 1910."

Average sample of dark and light gray oolitic limestone chips, the former fewer in number and containing more oolites than the latter.—J. S. M.

No. 3287. "Dark oolitic limestone, finely banded by false bedding planes; cross-bedded with beds from 3 to 15 inches thick, with dip of bedding planes steeply to the north, northwest; thickness 7 feet 11 inches to 7 feet. No. 5 of Mt. Vernon section. Lower member, Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of gray oolitic limestone, some of the chips were slightly weathered.—J. S. M.

No. 3288. "White oolitic limestone with stylolites planes 4 to 12 inches apart; occasional small flint nodules, calcite concretions and lenses of blue oolitic limestone, most beds being free from these irregularities; thickness 17 feet 10 inches. No. 10 of Mt. Vernon section. Mt. Vernon bed, Ste. Genevieve limestone. Kruger quarry, immediately south of depot, Mt. Vernon, Rockcastle county. Collected by F. J. Fohs, August 10, 1910."

Average sample of white oolitic limestone; a fine-grained limestone than the Bedford and contains a fewer number of oolites.—J. S. M.

No. 3289. "Crystalline oolitic limestone; thickness 24 feet 10 inches. Contains large crinoid stems, *Zaphrenti*, and *Agassizocrinus conicus*. Crinoid stem bed, Tribune limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of crystalline and oolitic limestones, contains cavities of iron oxide. Not a pure looking stone. —J. S. M.

No. 3290. "Blue to gray coarsely crystalline fossiliferous limestones, upper layers slightly ferruginous; thickness 23 feet 11 inches. Third limestone from base of Leitchfield formation. From outcrop on hill immediately south of Mt. Vernon depot, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of very dark gray limestone; a rather impure-looking stone.—J. S. M.

No. 3291. "Blue to gray, coarsely-crystalline to compact fossiliferous limestone; basal beds laminated and shaly; thickness 20 feet 6 inches. Basal limestone of Leitchfield formation. From outcrop on hill immediately south depot at Mt. Vernon, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of gray cryatalline limestone having conchoidal fracture; some coating of iron oxide on a weathered surface.—J. S. M.

No. 3292. "Dark compact, probbaly magnesian limestone; thickness, 12 to 19 inches. No. 24 of Mt. Vernon section. Upper member, Ste. Genevieve limestone. Sparks quarry, Rockcastle county. Collected by F. J. Fohs, August 9, 1910."

Average sample of light gray limestone; not a very pure looking specimen.—J. S. M.

No. 2606. Limestone; Rockcastle county near Gum Sulphur. ?Devonian (See L. B. 2427 B. & 2440 for earlier analyses). Collected by Dr. W. W. Burgin, October 1904. A gray, very crystalline, coarse-grained limestone containing pink crinoid stems and occasional spots of soft, green, clay-like material, Chemist remarks (Alfeed M. Peter): "This is a very pure limestone and should be

valuable as an ornamental stone on account of its handsome appearance when polished. An examination of the crinoid stems showed that the pink color was due to ferric oxide."

No. 3242. "Limestone, labeled 'From a quarry on Copper creek and Dix river in Rockcastle county, Ky. about 4 miles from Crab Orchard, on the east of the L. & N. Railroad, and about one mile from it, and about 12 miles northwest of Mt. Vernon. Bed 9 feet thick.' Sent by J. H. Sowder, August, 1891.

A dense rock of a light gray color, said to take a good polish.—A. M. P."

No. 3243. "Limestone, labeled 'Building stone' from the same quarry as No. 3242. Sent by J. H. Sowder, September, 1891.

Quite a hard, compact, light gray stone, containing a few fossil shells, and some small crystals. Mr. Sowder states that this stone withstands frost perfectly and takes a beautiful polish.—A. M. P."

No. 3390. "Clayey compact, possibly magnesian limestone; thickness 21 feet 6 inches. Orlando member, St. Louis limestone, 65 feet below base of Ste. Genevieve Railroad cut, immediately north of second tunnel north of Orlando, Rockcastle county. Collected by F. J. Fohs, August 17, 1910."

Laboratory No.	3256	3257	3258	3259	3260	3261	3262	3263	3264	3265	3266	3267	3268	3269
Moisture 100° C.	.08	.13	.10	.09	.13	.08	.17	.03	.19	.15	.09	.11	.14	.11
Ignition, CO_2, etc.	42.65	42.90	42.06	41.50	41.04	42.40	37.60	43.28	40.75	43.02	43.24	41.89	41.48	42.07
Silicia	2.82	2.26	3.02	4.88	5.60	3.00	16.00	.94	7.70	1.34	1.44	3.80	4.42	3.04
Alumina	1.14	.62	1.08	1.14	1.44	.43	3.32	.06	2.94	.24	.60	.48	1.12	.59
Ferric oxide	.32	.32	.16	.24	.24	.08	1.68	.16	.32	.08	.32	.32	.28	.12
Ferrous oxide	.29	.14	.14	.14	.14	.22	1.51	.14	.86	.22	.29	.14	.18	.18
Calcium oxide	49.00	53.00	52.40	51.20	49.80	52.40	27.80	53.80	39.09	54.88	52.53	52.86	51.80	52.53
Magnesian oxide	3.28	.56	.67	.50	.87	.54	11.48	1.04	7.96	.70	.97	.73	.70	.62
Sulphur trioxide	tr.	tr.	tr.	tr.	tr.	tr.	tr.	tr.	.13	.04	.035	.035	.074	.05
Phosphorus pentoxide	tr.	.04	tr.	.06	.16	.07	.20	tr.	.34	.30	.08	.12	.12	.07
Total	99.58	99.97	99.63	99.75	99.42	99.22	99.76	99.45	100.28	100.97	99.50	100.48	100.37	99.38
Calcium carbonate	87.50	94.64	93.57	91.43	88.93	93.57	49.64	96.07	69.80	98.00	93.80	94.40	92.50	93.80
Magnesium carbonate	7.09	1.18	1.41	1.05	1.83	1.13	24.11	2.18	16.71	1.48	2.02	1.53	1.47	1.30
Total carbonates	94.59	95.82	94.98	92.48	90.76	94.70	73.75	98.25	86.51	99.48	95.82	95.93	93.97	95.10
Available carbonates	83.50	87.76	83.50	76.90	71.05	85.10	19.65	95.45	56.22	94.73	90.11	83.95	78.46	84.94
Sulphur	tr.	tr.	tr.	tr.	tr.	tr.	tr.	tr.	.05	.016	.014	.014	.03	.02
Phosphorus	tr.	.017	tr.	.028	.07	.03	.086	tr.	.15	.13	.03	.05	.05	.03
Carbon dioxide	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Thickness of bed	5′ 8″	63′	8′ 6″	4′	20′	49′ 2″	12′ 6″	9′ 8″	32′	3′ 2″	20′ 6″	8′	?	1′ 9″
Name of bed	Upper part Mullins Compact Crystalline	Lower Ste. Gen.	Mullins	Basal bed Mullins	Lower Ste. Gen.		Keokuk	Sparks	Orlando	Pentremite coarse Crystalline	Crinoid stem Crystalline and oolitic	Lower Ste. Gen.	Lower Ste. Gen.	Middle Tribune Fine-Crystalline
Remarks		Dark oolitic	Compact lithographic	Crystalline semi-oolitic	Dark oolitic	Dark oolitic	Compact clayey	White oolitic	Compact clayey			oolitic	Dark oolitic	
Locality	Wildie	Wildie	Sinks	Sinks	Sinks	Sinks	Big Hill	Sinks	Big Hill	Sinks	Sinks	Big Hill	Dudley	Sparks

Laboratory No.	3270	3271	3272	3273	3274	3275	3276	3277	3278	3279	3280	3281	3282	3283
Moisture 100° C.	.09	.12	.16	.15	.14	.12	.11	.08	.10	.15	.03	.16	.03	.04
Ignition, CO_2, etc.	42.92	43.30	41.36	41.91	41.72	42.24	43.89	33.26	43.16	40.99	43.36	38.16	43.38	44.08
Silica	1.70	3.64	4.42	4.70	4.10	3.48	1.80	.96	1.90	6.28	1.20	12.16	.74	1.60
Alumina	.13	1.65	1.58	1.84	.07	1.05	.51	x .00	.91	.05	.31	.34	.21	.31
Ferric oxide	.72	.72	.20	.12	.20	.04	.00	.00	.00	.00	.12	.56	.04	.24
Ferrous oxide	.22	.36	.18	.32	.11	.18	.32	.22	.36	.14	.18	.22	.11	.36
Calcium oxide	52.86	40.10	50.82	46.97	52.69	52.43	46.78	54.56	49.83	51.13	52.86	47.98	54.9	45.36
Magnesium oxide	.71	9.60	.91	3.60	.62	.69	6.49	.43	3.21	.62	1.99	.38	.54	7.75
Sulphur trioxide	.043	.07	.04	.04	.02	.065	.034	.04	.04	.04	.01	.01	.02	.02
Phosphorus pentoxide	.09	.15	.06	.12	.09	.09	6.06	.12	.028	.09	.03	.036	.03	.05
Total	99.48	99.71	99.73	99.77	99.76	100.39	100.04	99.67	99.54	99.49	100.09	100.01	100.06	99.81
Calcium carbonate	94.40	71.60	90.75	83.88	94.09	93.63	83.53	97.42	88.98	91.31	94.40	85.54	98.15	81.00
Magnesium carbonate	1.49	20.16	1.91	7.56	1.30	1.45	13.69	.90	6.74	1.30	4.18	.80	1.13	16.27
Total carbonate	95.89	91.76	92.66	91.44	95.39	95.08	97.22	98.32	95.72	92.61	98.58	86.34	99.28	97.27
Available carbonate	90.77	76.95	75.86	73.13	83.71	82.20	90.75	95.63	88.85	74.94	94.35	51.34	96.62	91.92
Sulphur	.017	.03	.02	.02	.007	.026	.014	.014	.014	.014	.0055	.002	.005	.005
Phosphorus	.04	.06	.028	.05	.04	.04	.05	.05	012	.04	.01	.016	.012	.023
Carbon dioxide	.....	.....	.....	41.36	42.20	.....	.....	42.88	.....	.....	.....	.....	.....	.....
Thickness of bed	4′	?3′	2′ 6″	3′ 6″	1′ 8″	0′ 8″	3′ 4″	2′ 6″	1′	5′ 6″	9′ 5″	7′ 6″	4′	4′
Name of bed	Pentremite	Top Ste. Gen.	Upper Ste. Gen.	Upper Ste. Gen.	Upper Ste. Gen.	Mt. Vernon bed	Upper Ste. Gen.	Sparks bed	Sparks bed	Middle Ste. Gen.	Sparks	Lithostrotion bed	Mt. Vernon	Mt. Vernon
Remarks	Coarse Crystalline	Compact brecciated shale	Granular Compact	Compact	Crystalline	Gray oolitic	Soft Compact	Gray oolitic	Crystallinf Compact	Compact Flinty	White oolitic	Compact, Flinty	White oolitic	Buff oolitic
Locality	Sparks	Sparks	Sparks	Sparks	Sparks	Sparks	Sparks	Sparks	Sparks	Sparks	Sparks	Big Hill	Sparks	Sparks

Laboratory No.	3284	3285	3286	3287	3288	3289	3290	3291	3292	2606	3242	3243	3390
Moisture 100° C.	.08	.10	.14	.13	.02	.07	.11	.12	.13	.11	4.53	4.24	.....
Ignition, CO_2, etc.	43.70	41.60	40.80	40.84	43.50	43.00	41.80	41.86	42.82	43.78	40.87	38.44	.....
Silica	1.24	4.70	6.56	5.72	.52	1.66	4.58	3.44	1.98	.27	1.36	4.00	.....
Alumina	.26	1.01	1.38	.74	.16	.52	.84	.21	.86	.41	1.36	5.60	.....
Ferric oxide	.00	.04	.08	.68	.08	.16	.00	.00	.00				
Ferrous oxide	.22	.18	.29	.18	.07	.22	.79	.43	.18	.....	.....	.....	.....
Calcium oxide	53.40	51.70	49.56	51.20	55.19	53.76	48.32	51.44	52.64	54.84	51.52	38.08	.....
Magnesium oxide	.70	.84	1.47	.85	.38	.67	2.28	1.76	1.50	.55	.36	9.64	.....
Sulphur trioxide	.10	.18	.09	.07	.01	.01	.57	.07	.03	.02	.....	.....	.....
Phosphorus pentoxide	.04	.05	.08	.08	.05	.02	.03	.05	.02	tr.	.....	.....	.....
Total	99.74	100.40	100.45	100.49	99.98	100.09	99.32	99.38	100.16	99.96	100.00	100.00	.....
Calcium carbonate	95.20	92.32	88.50	91.28	98.55	96.00	86.28	91.70	93.84	97.93	92.00	68.00	.....
Magnesium carbonate	1.47	1.76	3.09	1.78	.79	1.41	4.79	3.70	3.15	1.15	.75	18.16	.....
Total carbonate	96.67	94.08	91.59	93.06	99.34	97.41	91.07	95.40	96.99	99.08	92.75	86.16	.....
Available carbonate	92.47	78.09	69.36	74.97	97.48	91.31	75.89	85.28	89.04	97.18	85.13	59.28	.....
Sulphur	.04	.07	.035	.03	.0033	.004	.23	.03	.01	.....	.....	.....	.....
Phosphorus	.017	.022	.034	.034	.02	.008	.014	.021	.0087	.....	.....	.....	.....
Carbon dioxide	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Thickness of bed	3′ 6″	5′ 6″	9′ 2″	7′	17′ 10″	24′ 10″	23′ 11″	20′ 6″	1′ 9″	.....	.....	.....	21′ 6″
Name of bed	L0wer Ste. Gen.	Lower Ste. Gen.	Lower Ste. Gen.	Lower Ste. Gen.	Mt. Vernon	Crinoid stem	3rd Leitch field	1st Leitch field	Upper Ste. Gen.	Corniferous	Corniferous	Corniferous	Orlando
Remarks	Compact brecciated	Dark oolitic some flint	Dark oolitic sandy patches 3″ flint	Dark oolitic	Whitet oolitic	Crystalline and oolitic	Dark talline	Crystalline and semi-oolitic	Crystalline compact	.....	.....	.....	.....
Locality	Sparks	Sparks	Sparks	Sparks	Kruger	Sparks	Mt. Vernon	Mt. Vernon	Sparks	Copper Cr.	Copper Cr.	Copper Cr.	2d Orlando tunnel

Note.—Stratum was found in traces where looked for, and Titantium in all the clayey limestones.

USES OF LIMESTONE (COMPILED FROM ALL AVAILABLE SOURCES.)

Class I. Depenednt on Physical Characteristics.				Analyses numbers of representative available beds.
Building Stone	Finished exterior		Permanent buff, blue, or light gray color, massive and homogeneous, fine grained, free dressing, resist weathering and pressure, and absence of iron oxide or sulphide bitumen or efflorescence	3277, 3280, 3282, 3288.
	Rough	Bridges, Retaining walls, etc	Heavily bedded and free from gross imperfections	3257, 3259, 3260, 3261, 3265, 3266, 3267, 3268, 3270, 3283, 3285, 3286, 3287, 3289, 3290, 3291.
	Interior decoration: Beautiful appearance and take polish			Flint conglomerate at top of St. Louis, especially at Big Hill.
Crushed stone	Road metal, Ballast, Concrete		Pure limestone, gives good cementing power, and silica resistance to wear. Should pass 2½-inch ring and over ½-inch screen. Concrete rock should pass 2-inch ring	All except 3262, 3243, and 3390.
Lithographic stone			Homogeneous compact fine-grained stone, sufficiently porous to absorb oil, and free from veinlets, crystals, or perceptible grains. Sawed into slabs 3 to 4 inches thick	None.
Whiting:—Soft white limestone ground to 200 meash				?3282, ?3288.
Playing marbles:—White, lithography, buff, or blue compact limestone				?3276.
Class II. Dependent on Chemical Composition.				
A. Metallurgical Processes.				
Glass manufacture			Calcium-rich stone with maximum of 0.6% iron oxide, .75% magnesia, 1.5% alumina, and 8% silica	3257, 3258, 3259, 3261, 3265, 3267, 3268, 3269, 3274, 3275, 3277, 3279, 3282, 3284, 3288, 3289, 2606, 3242.
Ceramic bodies			Colloidal chalk whiting; soft white oolitic stone	3282, 3288.
Furnace lining			Silica and alumina 2.5%, magneisum carbonate 20 to 35.%, calcium carbonate 87. to 65.%	None.
Blast furnace flux			Available carbonates 85.%, max. silica and alumina 4.%	3257, 3261, 3263, 3265, 3266, 3269, 3270, 3276, 3277, 3278, 3280, 3282, 3283, 3284, 3288, 3289, 3291, 3296, 2606, 3242.
Open hearth flux			95% total or 89.5% available carbonates; max. of 5% magnesia, 1.5% alumina, 1% silica, 0.05% sulphur, 0.1% phosphorous	3263, 3265, 3266, 3270, 3277, 3280, 3282, 3284, 3288, 3289, 2606.
Calcium carbide, cyanide or carbide: Calcium rich stone (90% calcium carbonate.)				3257, 3258, 3259, 3261, 3263, 3265, 3266, 3267, 3268, 3269, 3270, 3372, 3274, 3275, 3277, 3279, 3280, 3282, 3284, 3285, 3287, 3288, 3289, 3291, 3292, 2606, 3242.

B. Limes.			
Calcium			Calcium carbonate 85%, magnesium carbonate 9%, other impurities 2.5% to make lime containing 90% lime, 5% magnesia, max. 5% impurities	3263, 3265, 3266, 3270, 3277, 3280, 3282, 3284, 3288, 3289.
Caustic:		**Hydrated:**		
Soda pulp process,		Compacting natural cement,		
Wood alcohol,		Compacting slag cement,		
Water purification,		Sand-lime brick,		
Calcium carbide,		Calcium nitrate,		
Calcium cyanide,		Insecticide,		
Ammonium sulphate,		Agricultural lime,		
Disinfectant,		Bleaching powder,		
Sugar refining,		Illuminating gas,		
Preserving eggs,		Ammonia,		
Soil drainage,		Fine glass, max. of 0.3% iron.		
		Tanning.		
		Depilatory,		
		Refractory brick,		
		Lime pencils,		
		Pottery glazes.		
Calcium or Magnesium				Either of those listed under calcium or Magnesian limestones.
Caustic:		**Hydrated:**		
Glycerine,		Compacting Portland cement,		
Lubricating oil		Polishes.		
Candles,				
Soap,				
Stone sawing,				
Glue,				
Bone ash,		Bone ash,		
Wood distillates,		Wood distillates,		
Steel and tin plate mills,		Steel and tin plate mills.		
Magnesium: Calcium carbonate 87.5% to 42%, magnesium carbonate 10 to 53%, impurities 2½%				3276, 3283.
Caustic:		**Hydrated:**		
		Mortar (calcium lime also used)		
		Plastering (calcium lime also used)		
		Sulphite pulp process,		
		Whiting: also air slaked,		
		Basic steel furnace lining,		
		Covering fire proofing,		
		Caustic potash,		
		Ceramic bodies.		

C. Cements.		
Hydraulic: 18 to 25% of silica and alumina		3262, 3390.
Natural rock cement: 20% aluminous matter		
Portland cement	Calcium-rich stone, (min. 63% calcium carbonate) with max. of 21% silica, 10% alumina, 6.5% ferric oxide, (13.5% combined alumina and ferric oxide), 5% magnesium carbonate; and absence of flint or coarse sand	3257, 3258, 3259, 3261, 3263, 3265, 3266, 3267, 3268, 3269, 3270, 3272, 3274, 3275, 3277, 3280, 3282, 3284, 3287, 3288, 3289, 3290, 3290, 3291, 3292, 2606, 3242.
D. Chemical Processes.		
Sugar refining	Calcium-rich lime with max. of 5% moisture and 3% magnesia, 3% silica, alumina, etc.	3263, 3265, 3277, 3280, 3282, 3284, 3288, 3289, 3292, 2602.
Soda ash: 95% calcium carbonate, low silica and iron		3265, 3270, 3277, 3280, 3282, 3284, 3288, 3289, 2606.
Caustic soda: Calcium rich stone		
Potassium brichromate: Calcium rich stone		
Chloride of lime	Calcium rich stone free from silica, iron, magnesia, or manganese	3263, 3282, 3288, 2606.
Sulphite pulp process: Magnesian porous stone		3262, 3390, 3283.
Agricultural lime	Minimum of 90% calcium carbonate, and max. of 5% magnesia, low silica and alumina. Crushed to 16 mesh or ground to 80 mesh	3257, 3258, 3261, 3263, 3265, 3266, 3267, 3270, 3277, 3280, 3282, 3284, 3288, 3289, 3292, 2606, 3242.

SAND AND GRAVEL.

Conglomerate sandstone.—This is chiefly of value for crushing for road metal, concrete, and pavements. After crushing the sand may be separated by screening and used for other purposes.

The Corbin conglomerate is about 45 feet thick on Elkins hill, but consists partly if not largely of pink sand beds. Its exact character could not be learned here as much of it is covered.

Near Sam R. Sam's land a conglomerate consists of large pebbles and rises to within ten feet below the New Livingston coal. This conglomerate must be 60 feet thick.

The lowest conglomerate, the Livingston is the only one thus far quarried, there being quarries at Dudley and at ————; this consists of alternate beds of coarse to fine soft sandstone and conglomerate. Sometimes as at Livingston, there is a bed of shale separating the conglomerate into two members. The Livingston conglomerate varies from a few to 89 feet inclusive of the shale member, and in places is absent. The most prominent areas available to transportation are those on either side of the railroad between Pinehill and Sinks and between Mullins and Livingston. Some of the beds are very pebbly and the cementing substance so soluble that under the influence of weathering it breaks down into beds of gravel suitable for concrete. Such beds were noted at a number of points but especially near Sinks.

Dudley Sand Quarry.—This is located one-quarter mile west of Dudley station and is the property of the Winchester Granite Brick Company, Inc., of Winchester, Ky.

The deposit consists of a bed of soft white sand stone 27 feet thick, the upper 7 or 8 feet being discolored by horizontal bands and lenses of siliceous iron ore. Above

this is 67 feet of sandstone conglomerate, chiefly white but often pink or purple or black, discolored especially in the upper part by iron seams, etc. This deposit consists of alternating layers 2 to 3 inches thick of sand and conglomerate, but all compacted, and usually horizontal, but often cross-bedded. The pebbles are usually less than one-half inch, sometimes an inch long. The sand grains are larger than those of the sandstone immediately below.

These beds form the basal part of the Rockcastle series and rest unconformably on limestone of Tribune and Ste. Genevieve age. These deposits outcrop and form large escarpments on the sides of the ridges. They are sufficiently above the railroad (about 175 feet to base of quarry) to permit of good arrangement to handle material by gravity, and about 1400 feet distant. The overburden consists of 2 to 3 feet of soil and subsoil, while in some places the stone is bare. No water has to be contended with.

This quarry was first opened 14 years ago. The stripping and rock are shot down together. The rock is blasted by putting in holes by means of hand drills to varying depths, the maximum being 20 feet. The holes are placed a distance from the breast equal to their depth. Dynamite is used for springing the holes and black powder for shooting them. For example, in two holes 15 or 20 sticks of dynamite were used to spring them and two to three kegs of powder to shoot them, they were 16 feet apart, and broke down about 1000 tons of conglomerate. The holes are placed from 8 to 16 feet apart when a battery is drilled.

The conglomerate is loaded on a two-wheel mule cart and moved to the two central bins at the aerial tram shed, while the sand is first pounded with hammers on the side of the picks and in pulverized condition put into steel cars

holding about one ton each, which are hoisted on two tracks by means of cable and mule whim to the aerial tram shed where it is dumped into 10 ton bins. 12 to 18 men are worked, 14 on the average. A Broderick and Bascom aerial tram with two buckets holding 1750 lbs. each, conveys the sand and gravel to the plant on the railroad, 1400 feet distant. At the shed, one man operates the brake, the full car pulling back the empty, two men are employed to push down the sand in the bins, and one to look after the whim. These are included in the total for the quarry.

The sand and conglomerate costs 30 to 33 cents (inclusive of stripping) to quarry per ton. The cost exclusive of stripping is about 22 cents.

The firesand is used for making sand-lime brick. It is also suitable for glass. The coarse sand screened from the conglomerate is suitable for abrasive purposes such as stone sawing, as well as for mortar and concrete. The pebbles are used for concrete.

The sandstone conglomerate upon receipt at the plant, is dumped from the tram buckets (a trip every 3 minutes. but could every 1½) into an American ring pulverizer Two men feed the crusher and dump buckets. The largest run per 10 hours has been 192.5 tons; 175 is nearer average. The capacity is much greater. From this the sand is elevated by a chain-bucket elevator, which empties into a $1\frac{3}{16}$-inch wire screen trommel, the undersize being shipped for mortar, concrete, etc. The oversize, about ⅜ to ½ inch goes by a canvas belt conveyor (8 inch) from the end of the screen to its bin. The sand falls directly into its bin. The bins for this coarse sand and gravele ach have a capacity of 200 tons and are stationed directly over the switch tracks there being bottom gates which empty into the cars.

Sparks Sand Quarry.—This is operated by the W. J. Sparks Co., and is located about one-half mile south of

Sinks, to the west of the railroad with which it is connected by a short switch. Here, there occurs about 65 feet of conglomerate sandstone (of the Livingston) immediately above the Leitchfield limestone.

The rock after quarrying is loaded by mule carts directly into gyratory-crusher hopper and after grinding is screened so as to make two products, gravel and sand, which are fed from bins stationed directly below the crusher to the railroad cars. The power for the crusher is supplied by a small engine and boiler. The sand sells at 65 cents and the gravel at 20 cents (rarely at 35 to 40 cents) per yard. The ratio of sand to gravel is said to be about 4 to 1. There are 18 men employed at this quarry.

Dudley Sand-Lime Brick Plant.—The soft sand from the sand quarry is dumped directly into the drier from the aerial tram buckets. The same men who feed crusher dump these also.

The drier consists of a series of layers of 1½-inch pipes connected by ells, with 6 inch centers, the layers being 4 inches apart, and the series 4 feet deep. The drier is 20 feet long and about 8 feet wide. It has a depth of 3 feet above the pipes, and a hopper boshed on two sides 6 feet deep below the pipes. The drier is unsatisfactory, a rotary being better. The sand feeds from this hopper automatically into a measurer which measures out 90 lbs. of sand at a time, going thence into the tube mill. In the meanwhile the lime is wheeled by barrow into a hopper above a Sturtevant O open door fine grinder, where it is pulverized to about the size of wheat; from this it is elevated by a bucket elevator 6 in. cups into another hopper from which it passes through a galvanized pipe into an automatic scale which weighs out 10 lbs. of limestone to 90 of the sand, and passes with the sand into the tube mill which pulverizes them to a powder.

The tube mill is 5 feet in diameter and 18 feet long, made by the Abbe Engineering Co. The powder from this passes through an 18 mesh wire screen trommel about 24 inches by 3 feet. The oversize goes back for regrinding, the undersize goes to a mixer four feet long and very similar to a log washer except that the blades are narrower and closer together. A stream of water is admitted to the mixer and is mixed with the sand and lime which is conveyed thus mixed in a cup belt elevator to the storage bins. These are two placed back to back with the outer sides inclined about 45°. These each have a capacity of 50 tons and are emptied on alternate runs, so that one stands (the charge must remain in them at least 24 hours) while the other is emptied. The lime during this period is charged to hydrate. The mixture from these is conveyed by a cup belt elevator to the level of the top of the hopper which feeds the brick press to which it is conveyed by means of a belt-conveyor. The press is a Boyd, made by the Boyd-Chisholn Co., and its capacity is 19,000 brick per day. The bricks are standard size. 850 to 900 are piled on a single flat car (3 ft. x 5½ ft.) upon a steel sheet ⅛ inch thick.

Twenty-one of these cars are wheeled at one time on the track into the steam cylinder, which is 76 feet long and 6 feet in diameter. 120 lbs. of steam pressure is then applied within the cylinder after its head has been placed steam-tight upon its end. After being kept thus for 10 hours the bricks undergo the change from a soft incompact mass to a solid brick, almost impervious to water and capable of withstanding high heat, but not great cold and freezing. The lime hydrate has combined with some of the silica to form calcium silicate which acts as a cement for the bulk of the sand grains, the steam under pressure effecting this change.

The brick are then ready to be wheeled into the storage shed or loaded directly into box cars with straw.

Power is supplied by a 72 inch x 18 feet boiler, 150 horespower, and an 125 horsepower Hamilton-Corliss engine. The boiler requires from 1 to 3½ tons of coal (Straight Creek, 4-inch run-of-mine $1.90 per ton) the former when only sand crusher is running, the latter when the plant is running full. The capacity of the plant is 19,000 bricks per 10 hours, but 18,000 is nearer the output when running; at present they run on alternate days. Fourteen men are employed at the plant, the average being 35 for the sand and lime quarries, lime kiln and plant together.

The cost of producing the bricks is about $5 per 1000. No. 1 front bricks being $10, f. o. b. cars. Common bricks $6.50. Dark gray bricks sell at $12.50, while good red bricks bring $14 to $15. The gray and red brick darken somewhat on exposure.

Efforts to produce a satisfactory red brick have thus far proven unsuccessful. For this purpose 35 lbs. ($8.45 per 100 lbs.) of the best oxide has been used per 1000 bricks, and again 130 lbs. (costing $2.45 per 100 lbs.) but neither is dark enough nor will stay red, though the former is the better of the two. All darken upon exposure. Efforts to produce a satisfactory enamel likewise have failed. for the enamel in each instance crazes. A white enamel can be put on the brick for $15.00 per 1000.

Ganister Rock.—This is a very fine-grained usually gray to white sand sometimes hardened into rock which consists of about 95 per cent. silica and about 5 per cent. clay. It is of value in the making of silica bricks which are serviceable as firebrick under certain conditions, may be used for filtering to some extent, and also in making sand-lime brick. It occurs rather extensively in the county in

connection with some of the coal beds, especially under the New Livingston coal.

The hill between Mt. Vernon and Buhr has from 6 to 8 feet of it beneath the New Livingston coal. At an opening made by Dr. Lovell on this hill, however, it has an 8 inch coal parting.

ROAD METAL AND ROAD BUILDING.

The materials for road building in the county are illimitable, the chief question being what rock is most suitable for this purpose. The limestones, sandstones and conglomerate sandstone can all be used, but the limestone and hard conglomerate should be given preference, since most of the sand is soft and likely to soon wash badly; the shales should not be used at all. Of the limestones, the dark oolitic limestone forming the lower 50 to 70 feet of the Ste Genevieve perhaps will prove the best all round road metal, though nearly any of the limestones except the earthy compact ones of the Orlando member and Keokuk, will prove good road metal. The hard Livingston conglomerate in the vicinity of Sinks and Livingston also may be used. The Corbin conglomerate and other soft sandstones are not serviceable and should be avoided as far as possible.

Rockcastle county when compared with other Kentucky counties may be said to have some fair roads. With the great availability of material accessible on the roads themselves, nearly material which a portable rock crusher might crush, and with the large quarries at hand which could supply road metal ready for use very cheaply, there is every reason why the county should have roads as good as any in the State. The only macadam road at present is that in Mt. Vernon and lending immediately out of that town. The great drawback is the lack of a competent county road supervisor, the present local supervisor being

absolutely ignorant of proper road building methods and unfortunately like one of the older supervisors, does not wish to be told the proper way to build roads. One of the common mistakes has been to dump shales, soft sandstone and other soft material into the center of the roads. Another is the failure to provide adequate ditching on both sides of the road and suitable culverts for drainage.

The roads as built at present either hug the water courses or else follow the center of the high ridges in the eastern more broken part of the county, while in the western part the shaly and sandy, more rolling country admits of a more systematic placing of the roads.

The present county levy for road purposes is 12 cents *ad valorem*; the annual appropriation for dirt roads is $2,500. There are 450 miles of dirt road in the county, kept in repair by militia and the taxation. The county owns four road graders.

WATER SUPPLY: SPRING HORIZONS.

This is dependent on the streams, springs and wells of the county; the great source of water, however, for domestic and industrial use are the abundant springs which certain of the geological horizons afford. Except on a few of the higher, ridges, there is everywhere a good and abundant water supply.

Dick river and its branches, Rockcastle river with Skaggs and Roundstone creeks and their branches dissect the county thoroughly and afford a considerable drainage.

The springs horizons are of greatest interest. The springs issuing from the limestone horizons afford an abundance of good potable waters. The waters which issue from the coal seams are commonly chalybeate and are not so good. The waters which issue from the freestone is a fairly good water. The two best and usually infallible horizons are the base of the Mullins member at the unconformity with the Orlando member, and at the base of the Tribune at the unconformity with the Ste. Genevieve; these give rise to innumerable springs. The only sulphur springs are from the base of the Ohio shale in the vicinity of Gum Sulphur.

The following table gives the position of the important water horizons of the county; with a knowledge of the surface rock and the use of the table of formations previously given, the depth to a certain water can be predicted within reasonable limits at any locality at which it is desirable to bore for water:

TABLE OF WATER HORIZONS.

Corbin conglomerate	No water.
Pinehill formation	Corley Hollow coal: Heaay flow strong chalybeate water. New Livingston coal: Chalybeate water above fireclay. Livingston coal: Chalybeate water, heavy flow. Some water issues from above all the fireclay beds.
Livingston conglomerate	No water.
Leitchfield formation	Shale member: No water. Upper limestone. Middle limestone and shale: Spring horizon. Lower limestone.
Tribune limestone	Fine spring horizon, usually at base but occasionally 10 feet below top.
Ste. Genevieve limestone	Spring horizon at or near base.
St. Louis limestone	Mullins member: Heavy flow, fine spring horizon. Orlando member: near base.
Keokuk limestone	Just above the geode bed, and 10 feet or more below the Atherton bed is a good spring horizon.
Waverly	Springs are noted at various horizons in the upper Cuyahoga and in one instance from 60 feet above the Ohio shale.
Ohio shale	In the lower Cuyahoga, usually one foot above the Ohio shale is a spring and well horizon. A short distance above the base of the black shale, sulphur springs occur.

MISCELLANEOUS.

General.—It remains to describe what other products the county has and to mention such as it is useless to look for within its borders.

The only metallic minerals found are zinc blende and

iron ore, neither of which are in quantity. Thus neither of these, lead, silver, gold, or other metals need be looked for.

Small quantities of barytes, zinc ore, phosphate rock, and iron ore together with the possibilities for oil and gas will be next discussed briefly:

Asphalt Rock.—The only locality at which a bituminous sandstone was seen was in the Lovell hill northwest of Mt. Vernon. Here shortly above the Livingston coal is a sandstone which was prospected by Dr. Lovell but which shows only a very small amount of bitumen. It is not believed to be worthy of further investigation.

Barytes prospect.—This is on the A. J. Reams land 200 yards east of the station at Dudley. Barytes occurs in large boulders which weathered from the limestone breccia at the top of the Orlando member of the St. Louis limestone, which the barytes originally cemented. From a prospect pit 7½ feet deep, a number of large boulders were taken. The extent of the deposit is obscure but it is unlikely that a sufficient amount occurs here to warrant development.

Zinc prospects.—At the head of Sinking creek, one mile and a half southeast of Hansford on the Nichols (formerly Joel Woodall land), a ferruginous compact limestone bed about four feet thick outcrops above a spring. This limestone contains small segregations of barytes, calcite, and zinc blende, which are of no value. The limestone belongs in the shale of the Livinston conglomerate, the lower sandstone of which outcrops below the spring.

Likewise on the Buck French land, this same limestone contains zinc blende with barytes in segregations. The section here is as follows:

	Feet	In.
Livingston coal:		
Internal with slate at top	35	0
Micaceous sandy slate	3	0
Gray compact ferriferous limestone	1	2
Gray slate	2	0
Gray compact ferriferous limestone	0	6
Gray calcareous shale	3	0
Compact ferriferous limestone contains geodes of zinc blende, etc	4	0

Phosphate Rock.—The limestones of the county have a very low phosphoric acid content, the maximum being 0.34 per cent., and in most instances it is little more than a trace. This shows at once the unlikelihood of finding phosphate rock among them. There are, however, three other horizons in which phosphatic material may be expected, but in none is it likely to prove in commercial quantity: 1. At the base of the Cuyahoga are shales containing phosphatic nodules, seen between Broadhead and Gum Sulphur; these nodules occur immediately above the Ohio black shale and are extremely rich in phosphoric acid; they occur scattered through the shale. 2. In the Upper Waverlyan a few feet below the top is a layer of calacreous fossiliferous sandstone which according to qualitative test made by the Survey chemist for the writer gave indications of a small percentage of phosphoric acid. This is the common fossil bed near the top of the Waverly. 3. According to Foerste and Linney, the lowest part of the Corniferous limestone elsewhere contains more or less phosphatic material; this layer was not seen in outcrop in Rockcastle so that its character here remains in doubt though as elsewhere it is not likely to prove sufficiently phosphatic to be of value.

Iron Ore.—Sullivan has described three bands of iron ore (carbonate or clay ironstone none of which are valuable here) in the Rockcastle series at elevations of 50,

100-110, and 200-225 feet above the Mississippian limestone. The lowest of these is in the shale bed which divides the Livingston conglomerate. There are also some ochreous beds in the upper shale member of the Leitchfield formation, but none of the beds are important.

Oil and Gas possibilities.—Two wells have been drilled both of which proved dry, one near Mullins, the other near No. 1 Tunnel about one mile west of Mt. Vernon; the latter was between 900 and 1000 feet deep. The following is the section obtained in the Mullin's well (from Bull. 1, Ky. Geological Survey, Oil and Gas, p. 160):

WELL NEAR MULLINS.

		Feet
Livingston conglomerate		100
Mississippian limestone		100
Waverly...	Fine sand (Big Injun' sand at the top)	150
	Shale	200
Ohio black shale (gas at 600 feet)		150
Heavy, sandy limestone		20
Niagara shale		30
Richmond- Maysville shaly blue limestone (gas at 765 feet)		300
Eden.....	Sandy limestone	90
	Thin crystalline limestones	200
Lexington gray crystalline limestones		150
Highbridge white lithographic limestone		

While there is nothing definite to be said regarding the oil and gas possibilities of the county, the monoclinal structure with local anticlinals and synclinals offers possibilities for prospecting. A more careful location of such axis should be undertaken prior to the location of test wells, and the wells located accordingly; wells started in the limestones should be sunk to a sufficient depth to intersect the Corniferous limestone at a depth of 425 to 750 feet. Wells starting in the Rockcastle series might, where the Waverly is under sufficient cover, get something in some of its lower sands, but more likely in the Corniferous below, which would be at depths ranging between 800 and 1200 feet.

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